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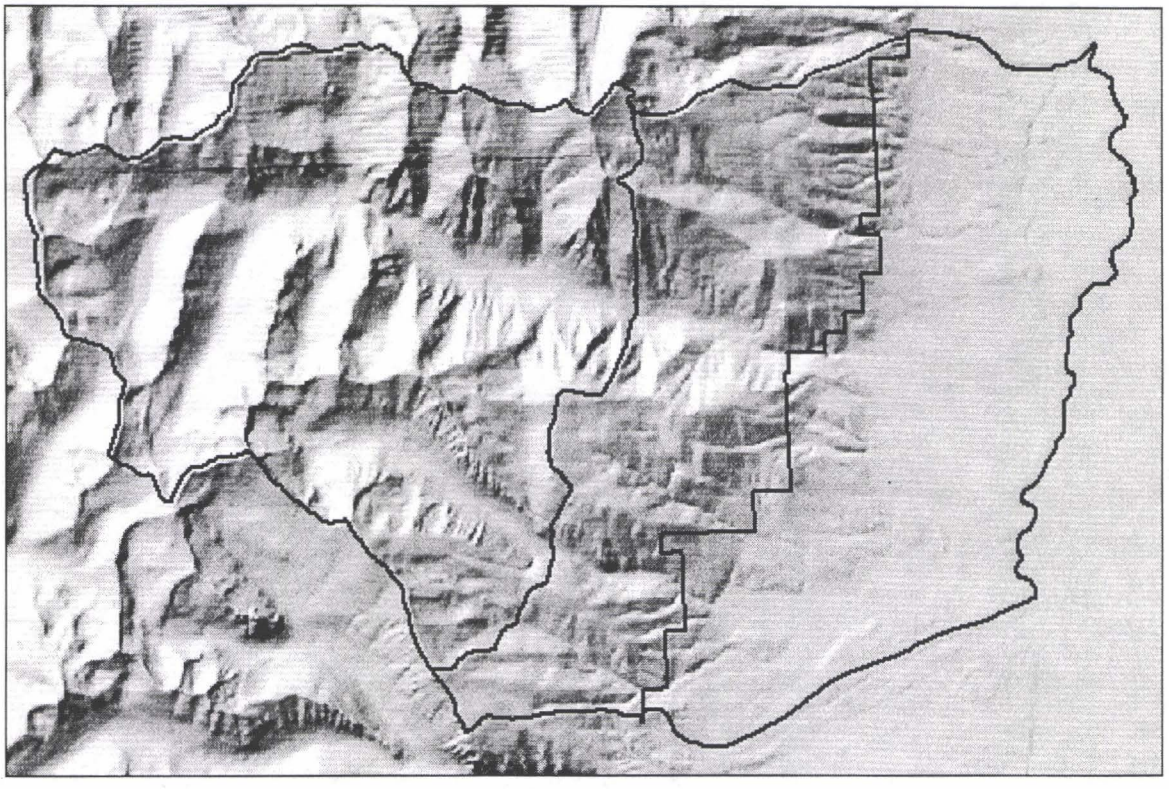

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Introduction

In 1996 the Bitterroot Ecosystem/Management Research Program completed a fine-scale assessment of a small landscape (60,000 acres) on the Bitterroot National Forest. During the fine-scale assessment (Phase I) investigators identified a set of questions associated with the scalability of assessment procedures and results. The primary goal of this phase of research (Phase II) was assessing the scalability of fine-scale procedures and results within the context of a 300,000-acre assessment area. The mid-scale assessment area of Phase II was a five-fold increase in area of concern over the fine-scale assessment area of Phase I. The Landscape Group of the Bitterroot Ecosystem/Management Research Program compiled the following eight objectives to meet this goal:

- Objective 1 - Test the effect of an alternative mid-scale stand type classification on process events for a fine-scale assessment. Measure the extent to which an alternative data source alters perceptions of natural processes and vegetative condition occurring within the Stevensville West Central Sub-planning Unit, and whether it is expected to alter management decisions.
- Objective 2 - Formulate and test models for conducting landscape analyses and measure the extent to which different levels of aggregation within a hierarchical classification of vegetation alters our perception of natural processes and vegetative change occurring within a sub-planning unit assessment area.
- Objective 3 - Measure the extent to which a change in extent alters perceptions of natural processes and vegetative condition occurring within the Stevensville West Central Sub-planning Unit, and whether it is expected to alter management decisions.
- Objective 4 and 5 - Refine and expand SIMPPPLE by integrating aquatic and landform processes for conducting mid-scale and fine-scale assessments.
- Objective 6 - Refine and expand the capabilities of MAGIS by adding an option to project vegetative change using states and pathways that would be consistent with SIMPPLLE.
- Objective 7 - Asses data sources and information provided by CRB and determines to what degree they may contribute to mid- and fine-scale analyses.
- Objective 8 - Integrate information from the BEMRP vegetation and fauna studies into landscape analyses for mid- and fine-scale analyses.

Objectives 1 and 3 were either partially or fully addressed within this report. Objectives 4, 5 and 7 were addressed in Landscape Analysis for Planning Units Final Report for USDA Forest Service Rocky Mountain Research Station (Agreement No. INT-96104-RJVA). Other researchers address objectives 2, 6 and 8.

Objective 1

Introduction

For each issue there is an appropriate spatial extent, spatial grain (resolution), and sampling intensity required to effectively address a particular question. In reality, due to the expense of data collection, we often deviate from the 'ideal' and adapt assessment questions to existing or readily available data sources. Adapting assessment questions to data sources implies a change in scale, resolution or extent in the question. The change in interpretations due to adapting questions to data is not well understood or documented.

In a similar manner, if broad-scale analyses establish context for finer scales, then vegetation analyzed at the mid-scale should provide a context for fine-scale interpretations. As an example, we could substitute a mid-scale characterization of vegetation into fine-scale analytical procedures and measure the change in outcomes. In the analysis presented in this report we evaluate the extent to which an alternative classification of vegetation may alter perceptions of natural process and vegetative change, and whether a change in perception is expected to alter a management decision. We assume that if a change in classification (change in context) alters interpretations, then a decision based on those interpretations is also likely to change. The null hypothesis for this analysis states that given an alternative classification of vegetation at a coarser scale there is no real difference perceived in the frequency and distribution of process events at the next finest scale. Since there is no change in the perception of natural processes, then management decisions based on those perceptions are unlikely to change.

The two classifications of vegetation considered in this analysis were the USFS Timber Stand Management Record System (TSMRS) and the USFS Northern Region's 1996 Satellite Image Land-cover Classification (SILC)(Redmomd, 1996). TSMRS is considered a viable source of vegetation information for fine-scale assessments and was applied in the Stevensville West Central Sub-planning Unit assessment (Phase I). The SILC data was considered a viable source of information for mid-scale assessments in that it provided a continuous uniform classification of vegetation over large extents.

The SIMPPLLE model (Chew, 1995) provided the framework for modeling the dynamics of disturbance regimes and their range of variability given TSMRS and SILC vegetation types as inputs to the model. SIMPPLLE is a stochastic model for simulating stand development, mountain pine beetle, western spruce budworm, root disease and fire processes with in a landscape. An existing type classification is typically the foundation for formulating states and pathways within SIMPPLLE. Through multiple simulations, SIMPPLLE provides a prediction of general behavioral trends and can provide a manager with a means to evaluate management activities in the context of landscape processes.

Data Sources

The TSMRS stands were delineated on 1:15,840 color photos and transferred to digital orthophoto quads using heads-up digitizing. The orthophoto quads were created from 1:40,000 high altitude black and white photography. A single experienced individual conducted all photo-interpretation. Sources for the TSMRS assignment of species composition, size class, structure class, and density class (percent canopy closure) varied from in-place designed inventories to photo-interpreted estimates. The TSMRS stand delineation defined the atomic vegetative element for the fine-scale assessment.

The SILC assignments were the result of a full-scene supervised classification. The classification process was fully documented in "Current Vegetation Map of Northern Idaho and Western Montana" produced by the Wildlife Spatial Analysis Lab at The University of Montana and the Northern Region of the USFS (Redmond, 1996). SILC differs from TSMRS primarily in extent (population being sampled) but not necessarily in grain-size (resolution) or scale. Accuracy was reported in the source documentation for SILC, but no determination was made as to the accuracy of TSMRS.

Initial Study Design

The initial study design called for the development of SILC specific states and pathways within SIMPPLLE, and a subsequent comparison of the event spectrum produced by the model. Our initial method was to develop pathways in SIMPPLLE that are appropriate to SILC and reflect an enhanced understanding of the variability in species

composition and stand structure represented by the SILC land-cover classification. Since SILC offered a more generalized classification of vegetation than TSMRS, there would likely be fewer states and pathways required for representing vegetative change. Within the Stevensville West Central assessment area, we identified 19 SILC forest types and 31 TSMRS 31 forest types.

To develop SILC specific states and pathways for SIMPPLE we selected a subset of plots from the USFS Northern Region Ecodata collection that were within a geographically and ecological similar area. The plots considered were geographically coincident with the Upper Clark Fork Assessment Zone geographic boundary as delineated by the USFS Northern Region, and had a SILC cover-type and potential-vegetation type assigned. Plots were stratified by SILC cover-type and potential vegetation type. The USFS Northern Region potential vegetation old-growth groups defined the potential vegetation types for stratification (types A through J). The western Montana potential vegetation groups were:

- Group A - warm and dry
- Group B - moderately warm and dry
- Group C - moderately cool and dry
- Group D - optimum temperature and moisture
- Group E - cool and moist
- Group F - wet
- Group G - moderately cool and moist
- Group H - cool and moderately dry
- Group I - cold and moderately dry
- Group J - cold

The Bitterroot National Forest lacked a potential vegetation geographic data theme derived independently of the TSMRS stand polygon delineation. Therefore, potential vegetation old-growth habitat type groups were assigned to SILC stand polygons on the basis of majority representation within coincident TSMRS polygons.

The USFS Northern Region STRATA programs were employed to generate descriptive reports on frequency of species (species composition) and structural distributions within each SILC cover-type/potential-vegetation combination. We considered four (4) ground-truth plots as the minimum number of plots necessary to develop a constancy/coverage table that represents the species diversity within each combination. This descriptive information provided the foundation for developing

vegetative state and pathway descriptions within SIMPPLLE. The better the description of diversity within these types, the better the pathways reflected realistic changes in state for any given process. Our investigation determined that of the 154 SILC cover-type/potential-vegetation combinations identified for the assessment area, only 60 were considered ecologically typical. That is, 94 of the 154 types identified were ecologically atypical in that they represented a cover-type/potential-vegetation combination that most likely did not occur. A lodgepole pine cover-type on a Group A potential vegetation type that would typically support ponderosa pine was an example of an ecologically atypical combination. Of the 60 combinations considered ecologically typical, the Northern Region Ecodata collection had sufficient plot data to represent 21 of the 60 viable combinations. The plot counts for these combinations are presented in Table 1.

Table 1: Number of ecodata plots per SILC cover-type/potential-vegetation combination for the Upper Clark Fork Assessment Zone for combinations represented in ecodata (21 of 154).

Satellite TM imagery (SILC) cover-type class	USFS Northern Region Old-growth habitat type group	Number of Ecodata plots in Upper Clark Fork Assessment Area
4203 - Lodgepole pine	B	3
4203 - Lodgepole pine	C	3
4203 - Lodgepole pine	E	6
4203 - Lodgepole pine	H	17
4203 - Lodgepole pine	I	3
4206 - Ponderosa pine	A	5
4206 - Ponderosa pine	B	11
4212 - Douglas-fir	C	6
4212 - Douglas-fir	E	3
4212 - Douglas-fir	G	3
4215 - Western Larch	E	4
4219 - Mixed alpine forest	I	8
4219 - Mixed alpine forest	J	7
4220 - Mixed subalpine forest	E	7
4220 - Mixed subalpine forest	H	4
4221 - Mixed mesic forest	B	3
4221 - Mixed mesic forest	E	10
4221 - Mixed mesic forest	G	3
4222 - Mixed xeric forest	A	4
4222 - Mixed xeric forest	B	12
4223 - Douglas-fir/Lodgepole pine	E	3

Our investigation concluded that there was insufficient plot data within the Upper Clark Fork Assessment Zone to develop SILC specific states and pathways for SIMPPLE. We were advised that similar plots outside of the Upper Clark Fork Assessment Area would probably not adequately represent vegetative conditions found within the Upper Clark Fork Assessment Zone. Since plot data within an ecologically similar area were not available for all combinations, we had to develop an alternative analytical approach.

The next best alternative was to map SILC attributes to existing states within SIMPPLLE. Using this approach, we contrasted the event spectrums (frequency and area of events) produced from a set of input scenarios using states and pathways developed specifically for TSMRS-level data. There was a distinct advantage to this approach in that existing states and pathways within SIMPPLLE became a constant with inputs allowed to vary. In the initial analytical design discussed earlier, states and pathways were specific to the SILC classification. Our alternative approach had two very distinct disadvantages. First, we had to decompose the cover-type, structure-size type, and canopy-closure type SILC stand attributes into their TSMRS equivalent as represented by existing states within SIMPPLLE. Since we lacked comparative type classifications, the process of decomposing SILC types was somewhat but not entirely subjective. The conversion or decomposition rules applied to SILC types are discussed within the body of this report. Secondly, the lack of SILC specific states within SIMPPLLE meant that the classification to event comparison moved one step away from the original intent. This would undoubtedly result in more diversity within a projected landscape than if a SILC specific model were developed. This was due to the fact that the mid-scale SILC data was passed through a fine-scale set of states and pathways. Even given these concerns, we felt it was worthwhile to proceed. It was important to gain some knowledge about the sensitivity of SIMPPLE to changes in input classifications. It was our view that the modified SILC classification considered in the following analysis was a realistic and viable alternative for comparing mid- and fine-scale event outcomes relative to the management issues and decisions considered important within the Stevensville West Central assessment area.

Modified Study Design

The modified study design evaluated the contribution of each of four (4) key attributes: composition of vegetation, structure-size distribution, tree canopy closure, and spatial arrangement of delineated stands to the resulting process event spectrum. Each analytical scenario isolates one of these attributes and quantified the degree to which a particular attribute altered perception of natural process and change in condition of forested vegetation. The analysis evaluated event outcomes in the context of landscape composition rather than landscape configuration. That is, event outcomes were summarized independent of spatial arrangement and reflected the aggregate of processes occurring within the Stevensville West Central assessment area. The landscape configuration or spatial redistribution of process events was not evaluated in this analysis and is a subject of further investigation.

The TSMRS data provided the baseline for comparing event outcomes as a result of landscape processes simulated within SIMPPLLE. In each of the following scenarios, one SIMPPLLE state attribute was modified to reflect the SILC data and all other state variables were held constant. For each scenario we discuss how the SILC attributes were decomposed and assigned to existing SIMPPLLE states. The simulation for each scenario covered five (5) decades and each simulation was repeated 100 times (100 samples). The event spectrum for each scenario was statistically evaluated for change in area and frequency of events against the TSMRS baseline developed for the assessment area. The null hypothesis for all scenarios state there was no real difference in the frequency or occurrence of events given 100 simulations within SIMPPLLE and TSMRS and SILC as inputs. This hypothesis was intrinsic to the sampled data since we were interested in testing the estimate derived from image classification against the photo-interpreted estimate. This hypothesis was not extrinsic to the sampled data since there was no preconceived theoretical distribution. A T-test pair-wise analysis of variance provided information for determining whether input attributes and event outcomes were significantly different based on acres. The T-test determined whether the mean acres for each population (baseline and scenario) were likely to be equal. A pair-wise Likelihood-Ratio Chi-squared test provided information to determine whether input attributes and event outcomes were significantly different based on frequency. This

is a *Model I* design (marginal totals not fixed) where only *n* (number of simulations) was fixed. These test were applied to the following four scenarios:

1. Change in tree canopy closure. Species composition, structure-size class and spatial arrangement held constant.
2. Change in tree structure-size class. Species composition, canopy closure and spatial arrangement held constant.
3. Change in species composition. Tree canopy closure, structure-size class and spatial arrangement held constant.
4. Change in spatial arrangement. Classifications of species composition, structure-size class and canopy closure held constant.

Scenarios 1, 2 and 3 tested a change in landscape composition by a majority assignment of each SILC attribute to each TSMRS stand polygon with spatial arrangement held constant. Scenario 4 tested a change in landscape configuration by a majority assignment of each TSMRS attribute to SILC stand polygons with composition held constant. These scenarios and the simulation results from SIMPPLLE are presented in detail in the body of this report.

Parametric assumptions

Some violation of parametric assumptions further complicated this analytical approach. Briefly these are:

1. All observations must be independent of each other. The TSMRS and SILC data were derived independently, but it was often the case that the TSMRS data in some way controlled the assignment of a SILC attribute to an existing TSMRS state. This reassignment was relatively objective in that it was based on a consistent and simple set of rules.
2. The scores must have been drawn from a Gaussian distribution. This is not true. The distribution of acres in both data sets is a Poisson rather than binomial distribution. The results of a non-parametric Chi-square approximation test was comparative to the T-test results in almost all cases, but the stronger T-test procedure allowed for an evaluation of population variance. Since all tests were pair-wise, the test procedure used is noted in all tables. If the non-parametric results differed from the T-test results, the non-parametric results were recorded. The 'test' column in each summary table identifies which test results were recorded. A value of 'equal' means a T-test with equal variances; a value of 'unequal' means a T-test with unequal variances; and a value of 'nonpar' means non-parametric test results were recorded.
3. The populations sampled must have equal variance. A folded statistic was computed to test for equality of variances between the two populations. This determined which T-test result to consider.

4. The populations sampled must have the same mean. Since scenarios 1, 2, and 3 used the same set of stand polygons, this was undoubtedly true. Scenario 4 purposely used a different set of stand polygons.

The critical alpha value was 0.05 for all tests. Since all tests were pair-wise, the degree of freedom was always 1. While it was difficult to ignore the violations of parametric assumptions, we felt the pool of statistical procedures and the literature was fairly weak for landscape comparisons given the composition and configuration complexity of this analysis. This project has inspired further investigation into appropriate statistical procedures for landscape comparisons. We proceeded with the analysis procedures outlined earlier with the assumption that the comparison will have value for ecological and model interpretations relative to the project objective.

Scenario I: Analysis of an Alternative Assignment of Canopy Closure Class.

The objective of this scenario was to test differences in event outcomes given a change in tree canopy closure with species composition, structure-size class and spatial arrangement held constant. An independent estimate of canopy closure class was derived from photo-interpretation of 1:24000 aerial photography and satellite TM imagery for the same geographic location. Our null hypothesis stated that there was no real difference in the sample mean acres or frequency distribution of events for a given canopy closure class based on data source alone. Source was the independent variable.

A rejection of the null hypothesis was interpreted as an interaction of a change in landscape composition (change in frequency of canopy classes) and/or a change in spatial configuration (spatial redistribution) since the population of stand polygons did not change. It was possible for the null hypothesis to be true and spatial configuration to be different, but we did not specifically test or quantify a change in spatial configuration. Testing for changes in spatial configuration was beyond the scope of this analysis, but a topic for further study.

The classification breakpoints for canopy closure in SIMPPLLE were not identical to those defined for SILC. Since the TSMRS data was the

source information for developing states within SIMPPLLE and provided the baseline data for our comparison, we identified the SIMPPLLE breakpoints as 'photo-interpreted' in subsequent tables. Table 2 identifies canopy closure class break points for each data source.

Table 2: Breakpoints for the percent of canopy closure by source. Acres and % of total area for SILC classes.

Photo-interpreted canopy closure classes	Satellite TM imagery			
	Canopy closure class	SILC label	Acres	% of total area
0 to 30%	0 to 14%	0	20172	34.9
31 to 49%	15 to 39%	1	21996	38.0
50 to 69%	40 to 69%	2	13389	23.1
70 to 100%	70 to 100%	3	2453	4.0

The following rules were applied to assign SILC classes to SIMPPLE states:

- The 0 to 14% SILC canopy closure class was assigned to the 0 to 30% class in SIMPPLLE.
- The 15 to 39% SILC canopy closure was assigned to either the 0 to 30% or 31 to 49% class in SIMPPLLE. If the SILC class intersected with a majority TSMRS canopy closure class of 0 to 30% or less, the 15 to 39% SILC canopy closure class was assigned to the 0 to 30% class in SIMPPLLE. Similarly, if the SILC class intersected with a majority TSMRS canopy closure class of 31 to 49% or greater, the 15 to 39% SILC canopy closure class was assigned to the 31 to 49% class in SIMPPLLE.
- The 40 to 69% SILC canopy closure was assigned to either the 31 to 49% or 50 to 69% class in SIMPPLLE. If the SILC class intersected with a majority TSMRS canopy closure class of 31 to 49% or less, the 40 to 69% SILC canopy closure class was assigned to the 31 to 49% class in SIMPPLLE. Similarly, if the SILC class intersected with a majority TSMRS canopy closure class of 50 to 69% or greater, the 40 to 69% SILC canopy closure class was assigned to the 50 to 69% class in SIMPPLLE.
- The 70 to 100% SILC canopy closure class was assigned to the 70 to 100% class in SIMPPLLE.

While aware of the SILC and TSMRS interaction effects, we felt the bias was toward TSMRS. That is, this reassignment of SILC most likely favored SILC in that where TSMRS canopy closure was low, the SILC class was pushed to the lower of two possible reassignments. The alternative was to randomly apportion the SILC class. We felt the application of prior knowledge was preferred and a best-case alternative given the

difficulties of decomposition. Visual comparisons of the original SILC distribution in Table 2 with the distribution in Table 3 support the effectiveness of this redistribution.

Table 3: Acres and percent of total area for each canopy closure class by source.

Canopy Closure Class	Source					
	Photo-interpreted			Satellite TM imagery		
	Total acres	% of area	Mean Acres	Total acres	% of area	Mean Acres
Non-forest	8429	14.5	29.7	9475	16.3	30.0
0% to 30%	26607	45.8	48.3	25169	43.3	48.9
31% to 49%	8311	14.3	32.1	12571	21.7	31.0
50% to 69%	9811	16.9	34.4	9540	16.4	35.9
70% to 100%	4942	8.5	31.1	1345	2.3	37.4

The analysis of variance T-test tests for differences in population means. The T-test results for each canopy closure class by source (alpha = 0.05) are summarized in Table 4 and support the null hypothesis. Each canopy closure class was tested independent of other classes. We concluded that the sample means for acres by canopy closure class were not significantly different between data sources.

Table 4: Pair-wise analysis of variance results for each canopy closure class by source.

Source	Test	Probability	Significant
Non-forest	Equal	0.9131	No
0% to 30%	Equal	0.9728	No
31% to 49%	Equal	0.6571	No
50% to 69%	Equal	0.5855	No
70% to 100%	Equal	0.2424	No

A second test, a Likelihood-Ratio Chi-square test, tests for differences in frequency of occurrence. This is a robust 2 x 2 Test of Association for canopy closure classes by source (alpha = 0.05). Our null hypothesis states there was no difference in the frequency of occurrence of a given canopy closure class by source. Each canopy closure class was tested independently and evaluated against the combined frequency of all other classes. The frequency and % of stand polygons in each class by source are presented in Table 5. The results of the Likelihood-Ratio Chi-square test for canopy closure are summarized in Table 6.

Table 5: Frequency and percent of total area for each canopy closure class by source.

Canopy Closure Class	Source			
	Photo-interpreted		Satellite TM imagery	
	N	% of stands	N	% of stands
Non-forest	284	18.5	316	20.6
0% to 30%	551	35.8	515	33.5
31% to 49%	259	16.9	405	26.3
50% to 69%	285	18.5	266	17.3
70% to 100%	159	10.3	36	2.3

Table 6: Pair-wise Likelihood-Ratio Chi-squared test results for each canopy closure class by source.

Canopy Closure Class	Probability	Significant
Non-forest	0.145	No
0% to 30%	0.173	No
31% to 49%	0.001	Yes
50% to 69%	0.372	No
70% to 100%	0.001	Yes

The Chi-squared test supports rejection of the null hypothesis and we can conclude the frequency distributions for the 31% to 49% and 70% to 100% canopy closure classes were significantly different based on source. In general, the SILC classification shifted the frequency of 70 to 100% closed canopies to open canopies by identifying fewer stands with closed canopies (70 to 100%), more stands with open canopies (31 to 49%), and more non-forest.

Analysis of Events by Source and Time Period given an Alternative Assignment of Canopy Closure Class

The following tables summarize the event spectrum for each decade (*t*) for 100 simulations of the Stevensville West Central assessment area. Each event is summarized in four tables. The first table summarizes acres by period for the event. The second table provides the analysis of variance T-test results. The third table summarizes the frequency by period for the event. The fourth provides the Likelihood-Ratio Chi-

squared test results. These four tables appear on the following pages for each of the following events:

- Succession or stand development
- Light severity fire
- Mixed severity fire
- Stand-replacing fire
- Light western spruce budworm
- Severe western spruce budworm
- Light mountain pine beetle in lodgepole pine
- Severe mountain pine beetle in lodgepole pine
- Mountain pine beetle in ponderosa pine
- Root disease
- Events that spread from a neighboring stand polygons
- Aggregation of severe events (includes stand-replacing fire, severe western spruce budworm, and severe mountain pine beetle)

The presentation of event tables conclude with an overall discussion on trends and interpretations.

Succession events

Table 7: Acres and percent of total area for succession events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Succession	1	47981.5	82.6	48384.5	83.3
Succession	2	47580.1	81.9	47473.9	81.7
Succession	3	46195.3	79.5	45963.2	79.1
Succession	4	43130.9	74.2	43171.5	74.3
Succession	5	41077.6	70.7	39940.6	68.7

Table 8: Pair-wise analysis of variance results for succession events by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Succession	1	Equal	0.9692	No
Succession	2	Equal	0.9846	No
Succession	3	Equal	0.9527	No
Succession	4	Equal	0.7774	No
Succession	5	Unequal	0.9216	No

Table 9: Frequency and percent of total area for succession events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Succession	1	1294.5	84.1	1304.5	84.8
Succession	2	1260.4	81.9	1257.1	81.7
Succession	3	1222.7	79.5	1215.1	79.0
Succession	4	1126.6	73.3	1120.9	72.9
Succession	5	1056.6	68.7	1025.1	66.7

Table 10: Pair-wise Likelihood-Ratio Chi-squared test results for succession events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Succession	1	0.001	Yes
Succession	2	0.125	No
Succession	3	0.001	Yes
Succession	4	0.022	Yes
Succession	5	0.001	Yes

Light-severity fire events

Table 11: Acres and percent of total area for light-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light-severity fire	1	284.2	<1.0	347.7	<1.0
Light-severity fire	2	233.6	<1.0	251.9	<1.0
Light-severity fire	3	247.1	<1.0	279.8	<1.0
Light-severity fire	4	331.4	<1.0	363.1	<1.0
Light-severity fire	5	335.5	<1.0	400.9	<1.0

Table 12: Pair-wise analysis of variance results for light-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process Event	t	Test	Probability	Significant
Light-severity fire	1	Unequal	0.1197	No
Light-severity fire	2	Unequal	0.7194	No
Light-severity fire	3	Unequal	0.8291	No
Light-severity fire	4	Unequal	0.8599	No
Light-severity fire	5	Unequal	0.4572	No

Table 13: Frequency and percent of total area for light-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light-severity fire	1	8.1	<1.0	8.8	<1.0
Light-severity fire	2	7.3	<1.0	8.0	<1.0
Light-severity fire	3	7.2	<1.0	7.9	<1.0
Light-severity fire	4	8.4	<1.0	9.4	<1.0
Light-severity fire	5	9.2	<1.0	10.2	<1.0

Table 14: Pair-wise Likelihood-Ratio Chi-squared test results for light-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Probability	Significant
Light-severity fire	1	0.137	No
Light-severity fire	2	0.054	No
Light-severity fire	3	0.047	Yes
Light-severity fire	4	0.017	Yes
Light-severity fire	5	0.018	Yes

Mixed-severity fire events

Table 15: Acres and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Mixed-severity fire	1	1800.1	3.1	1583.1	2.7
Mixed-severity fire	2	1368.5	2.4	1359.2	2.3
Mixed-severity fire	3	2201.6	3.8	2285.2	3.9
Mixed-severity fire	4	2613.8	4.5	2466.5	4.2
Mixed-severity fire	5	2361.5	4.1	2351.4	4.1

Table 16: Pair-wise analysis of variance results for mixed-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Mixed-severity fire	1	Unequal	0.1878	No
Mixed-severity fire	2	Unequal	0.4452	No
Mixed-severity fire	3	Unequal	0.9552	No
Mixed-severity fire	4	Unequal	0.6760	No
Mixed-severity fire	5	Unequal	0.9505	No

Table 17: Frequency and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Mixed-severity fire	1	36.7	2.4	35.3	2.3
Mixed-severity fire	2	31.4	2.0	32.0	2.1
Mixed-severity fire	3	52.0	3.4	54.1	3.5
Mixed-severity fire	4	58.7	3.8	56.2	3.7
Mixed-severity fire	5	54.8	3.6	54.7	3.6

Table 18: Pair-wise Likelihood-Ratio Chi-squared test results for mixed-severity fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Mixed-severity fire	1	0.097	No
Mixed-severity fire	2	0.462	No
Mixed-severity fire	3	0.042	Yes
Mixed-severity fire	4	0.018	Yes
Mixed-severity fire	5	0.907	No

Stand-replacing fire events

Table 19: Acres and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Stand-replacing fire	1	1937.2	3.3	1541.1	2.7
Stand-replacing fire	2	1215.3	2.1	1048.6	1.8
Stand-replacing fire	3	1398.5	2.4	1171.0	2.0
Stand-replacing fire	4	1512.3	2.6	1070.4	1.8
Stand-replacing fire	5	1052.5	1.8	882.5	1.5

Table 20: Pair-wise analysis of variance results for stand-replacing fire events by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Stand-replacing fire	1	Unequal	0.0029	Yes
Stand-replacing fire	2	Unequal	0.0376	Yes
Stand-replacing fire	3	Equal	0.9029	No
Stand-replacing fire	4	Unequal	0.6765	No
Stand-replacing fire	5	Unequal	0.0004	Yes

Table 21: Frequency and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Stand-replacing fire	1	52.7	3.4	39.9	2.6
Stand-replacing fire	2	32.6	2.1	27.0	1.8
Stand-replacing fire	3	37.7	2.5	31.58	2.1
Stand-replacing fire	4	39.9	2.6	28.9	1.9
Stand-replacing fire	5	29.9	1.9	22.5	1.5

Table 22: Pair-wise Likelihood-Ratio Chi-squared test results for stand-replacing fire events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Stand-replacing fire	1	0.001	Yes
Stand-replacing fire	2	0.001	Yes
Stand-replacing fire	3	0.001	Yes
Stand-replacing fire	4	0.001	Yes
Stand-replacing fire	5	0.001	Yes

Light western spruce budworm events

Table 23: Acres and percent of total area for light western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light budworm	1	5137.7	8.8	5239.0	9.0
Light budworm	2	5155.7	8.9	5339.8	9.2
Light budworm	3	5467.3	9.4	5774.5	9.9
Light budworm	4	7091.4	12.2	7402.7	12.7
Light budworm	5	8912.0	15.3	9722.5	16.7

Table 24: Pair-wise analysis of variance results light western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process Event	t	Test	Probability	Significant
Light budworm	1	Equal	0.6590	No
Light budworm	2	Equal	0.7815	No
Light budworm	3	Unequal	0.5473	No
Light budworm	4	Equal	0.1937	No
Light budworm	5	Unequal	0.4561	No

Table 25: Frequency and percent of total area for light western spruce budworm by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light budworm	1	123.8	8.1	126.9	8.3
Light budworm	2	142.1	9.2	146.7	9.5
Light budworm	3	147.5	9.6	157.1	10.2
Light budworm	4	204.6	13.3	217.3	14.1
Light budworm	5	256.5	16.7	282.3	18.4

Table 26: Pair-wise Likelihood-Ratio Chi-squared test results for light western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Probability	Significant
Light budworm	1	0.039	Yes
Light budworm	2	0.004	Yes
Light budworm	3	0.001	Yes
Light budworm	4	0.001	Yes
Light budworm	5	0.001	Yes

Severe western spruce budworm events

Table 27: Acres and percent of total area for severe western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe budworm	1	852.1	1.5	904.1	1.5
Severe budworm	2	2395.6	4.1	2471.6	4.3
Severe budworm	3	2135.6	3.7	2245.4	3.9
Severe budworm	4	2794.9	4.8	2971.0	5.1
Severe budworm	5	3854.6	6.6	4316.1	7.4

Table 28: Pair-wise analysis of variance results for severe western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process Event	t	Test	Probability	Significant
Severe budworm	1	Equal	0.6386	No
Severe budworm	2	Unequal	0.4983	No
Severe budworm	3	Unequal	0.9867	No
Severe budworm	4	Unequal	0.9894	No
Severe budworm	5	Unequal	0.6690	No

Table 29: Frequency and percent of total area for severe western spruce budworm by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe budworm	1	18.4	1.2	19.2	1.3
Severe budworm	2	60.3	3.9	63.0	4.1
Severe budworm	3	59.5	3.9	62.6	4.1
Severe budworm	4	82.0	5.3	87.2	5.7
Severe budworm	5	116.7	7.6	129.9	8.4

Table 30: Pair-wise Likelihood-Ratio Chi-squared test results for severe western spruce budworm events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Probability	Significant
Severe budworm	1	0.029	Yes
Severe budworm	2	0.013	Yes
Severe budworm	3	0.004	Yes
Severe budworm	4	0.001	Yes
Severe budworm	5	0.001	Yes

Light mountain pine beetle events in lodgepole pine

Table 31: Acres and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light LPP beetle	1	30.0	<1.0	27.3	<1.0
Light LPP beetle	2	11.6	<1.0	7.6	<1.0
Light LPP beetle	3	34.0	<1.0	26.9	<1.0
Light LPP beetle	4	70.0	<1.0	57.3	<1.0
Light LPP beetle	5	42.9	<1.0	24.7	<1.0

Table 32: Pair-wise analysis of variance results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Light LPP beetle	1	Equal	0.6592	No
Light LPP beetle	2	Unequal	0.9628	No
Light LPP beetle	3	Equal	0.6714	No
Light LPP beetle	4	Unequal	0.0242	Yes
Light LPP beetle	5	Equal	0.3606	No

Table 33: Frequency and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light LPP beetle	1	0.7	<1.0	0.6	<1.0
Light LPP beetle	2	0.3	<1.0	0.2	<1.0
Light LPP beetle	3	0.8	<1.0	0.6	<1.0
Light LPP beetle	4	2.4	<1.0	1.6	<1.0
Light LPP beetle	5	1.5	<1.0	0.9	<1.0

Table 34: Pair-wise Likelihood-Ratio Chi-squared test results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Light LPP beetle	1	0.179	No
Light LPP beetle	2	0.122	No
Light LPP beetle	3	0.270	No
Light LPP beetle	4	0.001	Yes
Light LPP beetle	5	0.001	Yes

Severe mountain pine beetle events in lodgepole pine

Table 35: Acres and percent of total area for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe LPP beetle	1	9.8	<1.0	12.6	<1.0
Severe LPP beetle	2	5.4	<1.0	4.2	<1.0
Severe LPP beetle	3	9.0	<1.0	6.6	<1.0
Severe LPP beetle	4	39.2	<1.0	18.7	<1.0
Severe LPP beetle	5	22.0	<1.0	12.1	<1.0

Table 36: Pair-wise analysis of variance results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Severe LPP beetle	1	Equal	0.9660	No
Severe LPP beetle	2	Equal	0.9832	No
Severe LPP beetle	3	Unequal	0.2443	No
Severe LPP beetle	4	Equal	0.0687	No
Severe LPP beetle	5	Equal	0.3645	No

Table 37: Frequency and percent of total area of severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe LPP beetle	1	0.3	<1.0	0.3	<1.0
Severe LPP beetle	2	0.1	<1.0	0.1	<1.0
Severe LPP beetle	3	0.3	<1.0	0.2	<1.0
Severe LPP beetle	4	1.3	<1.0	0.5	<1.0
Severe LPP beetle	5	0.9	<1.0	0.4	<1.0

Table 38: Pair-wise Likelihood-Ratio Chi-squared test results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Severe LPP beetle	1	0.438	No
Severe LPP beetle	2	0.548	No
Severe LPP beetle	3	0.099	No
Severe LPP beetle	4	0.001	Yes
Severe LPP beetle	5	0.001	Yes

Mountain pine beetle events in ponderosa pine

Table 39: Acres and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
PP beetle	1	36.2	<1.0	27.7	<1.0
PP beetle	2	54.1	<1.0	70.2	<1.0
PP beetle	3	144.0	<1.0	78.6	<1.0
PP beetle	4	222.2	<1.0	280.7	<1.0
PP beetle	5	124.7	<1.0	136.4	<1.0

Table 40: Pair-wise analysis of variance results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
PP beetle	1	Equal	0.8120	No
PP beetle	2	Unequal	0.3686	No
PP beetle	3	Equal	0.3536	No
PP beetle	4	Equal	0.4854	No
PP beetle	5	Equal	0.2523	No

Table 41: Frequency and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
PP beetle	1	1.8	<1.0	1.4	<1.0
PP beetle	2	1.3	<1.0	1.9	<1.0
PP beetle	3	3.9	<1.0	2.4	<1.0
PP beetle	4	6.8	<1.0	8.9	<1.0
PP beetle	5	3.6	<1.0	3.6	<1.0

Table 42: Pair-wise Likelihood-Ratio Chi-squared test results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
PP beetle	1	0.353	No
PP beetle	2	0.001	Yes
PP beetle	3	0.001	Yes
PP beetle	4	0.001	Yes
PP beetle	5	0.940	No

Root disease events in ponderosa pine

Table 43: Acres and percent of total area for root disease events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Root disease	1	31.2	<1.0	32.9	<1.0
Root disease	2	80.1	<1.0	73.0	<1.0
Root disease	3	267.6	<1.0	268.8	<1.0
Root disease	4	293.9	<1.0	298.1	<1.0
Root disease	5	316.7	<1.0	312.8	<1.0

Table 44: Pair-wise analysis of variance results root disease events by source and time period given an alternative assignment of canopy closure class.

Process Event	t	Test	Probability	Significant
Root disease	1	Equal	0.3938	No
Root disease	2	Equal	0.9926	No
Root disease	3	Equal	0.7427	No
Root disease	4	Equal	0.7871	No
Root disease	5	Equal	0.5084	No

Table 45: Frequency and percent of total area for root disease events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Root disease	1	1.0	<1.0	1.1	<1.0
Root disease	2	2.2	<1.0	2.0	<1.0
Root disease	3	6.4	<1.0	6.5	<1.0
Root disease	4	7.3	<1.0	7.5	<1.0
Root disease	5	8.3	<1.0	8.4	<1.0

Table 46: Pair-wise Likelihood-Ratio Chi-squared test results for root disease events by source and time period given an alternative assignment of canopy closure class.

Process event	t	Probability	Significant
Root disease	1	0.588	No
Root disease	2	0.348	No
Root disease	3	0.802	No
Root disease	4	0.676	No
Root disease	5	0.902	No

Events spread from neighbors

Table 47: Acres and percent of total area for events spread from neighbor by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Spread from neighbor	1	5148.3	8.9	4578.7	7.9
Spread from neighbor	2	3068.0	5.3	3098.7	5.3
Spread from neighbor	3	3619.9	6.2	3542.3	6.1
Spread from neighbor	4	4561.5	7.9	3975.6	6.8
Spread from neighbor	5	4564.3	7.9	4884.2	8.4

Table 48: Pair-wise analysis of variance results for events spread from neighbor by source and time period given an alternative assignment of canopy closure class.

Process Event	t	Test	Probability	Significant
Spread from neighbor	1	Unequal	0.6598	No
Spread from neighbor	2	Unequal	0.3026	No
Spread from neighbor	3	Unequal	0.7199	No
Spread from neighbor	4	Unequal	0.0515	No
Spread from neighbor	5	Unequal	0.2263	No

Table 49: Frequency and percent of total area for events spread from neighbor by source and time period given an alternative assignment of canopy closure class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Spread from neighbor	1	113.3	7.4	101.9	6.6
Spread from neighbor	2	80.6	5.2	80.0	5.2
Spread from neighbor	3	90.1	5.9	88.8	5.8
Spread from neighbor	4	111.2	7.2	101.2	6.6
Spread from neighbor	5	117.5	7.6	122.8	8.0

Table 50: Pair-wise Likelihood-Ratio Chi-squared test results for events spread from neighbor by source and time period given an alternative assignment of canopy closure class.

Process event	t	Probability	Significant
Spread from neighbor	1	0.001	Yes
Spread from neighbor	2	0.615	No
Spread from neighbor	3	0.306	No
Spread from neighbor	4	0.001	Yes
Spread from neighbor	5	0.001	Yes

Severe events

Table 51: Acres and percent of total area for severe events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe events	1	2799.1	4.8	2457.7	4.2
Severe events	2	3616.3	6.2	3524.4	6.1
Severe events	3	3543.1	6.1	3422.9	5.9
Severe events	4	4346.4	7.5	4060.1	7.0
Severe events	5	4929.2	8.5	5210.7	9.0

Table 52: Pair-wise analysis of variance results for severe events by source and time period given an alternative assignment of canopy closure class.

Process Event	*t*	Test	Probability	Significant
Severe events	1	Unequal	0.0009	Yes
Severe events	2	Equal	0.6307	No
Severe events	3	Unequal	0.9660	No
Severe events	4	Unequal	0.5008	No
Severe events	5	Unequal	0.1206	No

Table 53: Frequency and percent of total area for severe events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe events	1	71.3	4.6	59.5	3.9
Severe events	2	93.0	6.0	90.1	5.9
Severe events	3	97.5	6.3	94.3	6.1
Severe events	4	123.2	8.0	116.2	7.6
Severe events	5	147.5	9.6	152.8	9.9

Table 54: Pair-wise Likelihood-Ratio Chi-squared test results for severe events by source and time period given an alternative assignment of canopy closure class.

Process event	*t*	Probability	Significant
Severe events	1	0.001	Yes
Severe events	2	0.023	Yes
Severe events	3	0.015	Yes
Severe events	4	0.001	Yes
Severe events	5	0.001	Yes

Overall Event Summary for Canopy Closure

Table 55 provides a summary of event outcomes given an alternative assignment of canopy closure class from SILC. The 'Signif. Periods' column identifies the number of periods out of 5 where the statistical test was significant (null hypothesis rejected). The 'Trend' column indicates that the direction of change is increasing (+), decreasing (-) or modulating (±) across periods. An increase is interpreted as a net gain across periods, a decrease as a net loss across periods, and a modulation as compensating net gains and net losses across periods but with a redistribution as to when events occur among periods.

Table 55: Summary of event outcomes given an alternative assignment of canopy closure class.

Process event	Test Summary			
	Analysis of Variance on acres		Frequency of occurrence	
	Signif. Periods	Trend	Signif. Periods	Trend
Succession	0		4	-
Light-severity fire	0		3	+
Mixed-severity fire	0		2	±
Stand-replacing fire	3	-	5	-
Light budworm	0		5	+
Severe budworm	0		5	+
Light LPP beetle	1	-	2	-
Severe LPP beetle	0		2	-
PP beetle	0		3	±
Root disease	0		0	
Spread from neighbor	0		3	±
Severe events	1	±	5	±

We conclude that the sample mean acres by period for stand-replacing fire and light LPP beetle events were significantly different between sources given an alternative assignment of canopy closure. There was a decrease in mean acres of stand-replacing fire and light LPP beetle. The frequency of succession, stand-replacing fire, budworm and LPP beetle events are significantly different between sources given an alternative assignment of canopy closure. There was a decrease in the frequency of succession, stand-replacing fire, and LPP beetle events. There was an increase in the frequency of light-severity fire and budworm events. Some of these differences were somewhat counter to our interpretation of the inputs based on changes in canopy closure alone. We would expect an

increase in succession events and fewer stand reducing events with an overall decrease in canopy closure. One possible conclusion is that there was a redistribution of canopy closure classes that resulted in an event matrix that was quite different than the TSMRS baseline. The increase in open canopies did shift the frequency of stand-replacing fire to light- or mixed-severity fire events. This increase in open canopies did result in a reduction in mountain pine beetle events in lodgepole pine. The increase in budworm events was most likely related to the decrease in stand-replacing fire events. Stand-replacing fire events would most likely shift species composition to non-host species for budworm.

Scenario II: Analysis of an Alternative Assignment of Structure-Size Class.

The objective of this scenario was to test differences in event outcomes given a change in structure-size class with canopy closure, species composition, and spatial arrangement held constant. An independent estimate of structure-size class was derived from the TSMRS database and satellite TM imagery for the same geographic location. SILC classified size but not structure, so all SILC structures were assumed to be not multi-sized (multi-storied) within SIMPPLE. Our null hypothesis stated that there was no real difference in the sample mean acres or frequency distribution of events for a given structure-size class based on data source alone. Source was the independent variable.

A rejection of the null hypothesis was interpreted as an interaction of a change in landscape composition (change in frequency of structure-size classes) and/or a change in spatial configuration (spatial redistribution) since the population of stand polygons did not change. It was possible for the null hypothesis to be true and spatial configuration to be different, but we did not specifically test or quantify a change in spatial configuration. Testing for changes in spatial configuration was beyond the scope of this analysis.

The classification breakpoints for size in SIMPPLLE were not identical to those defined for SILC. Since the TSMRS data was the source information for developing states within SIMPPLLE and provided the baseline data for our comparison, we identified the SIMPPLLE

breakpoints as 'photo-interpreted' in subsequent tables. Table 56 identifies size-class break points for each data source.

Table 56: Breakpoints for size class by source. Acres and % of total area for SILC classes (forest types only).

Photo-interpreted size classes	Satellite TM imagery			
	Size classes	SILC label	Acres	% of total area
<5"	<5"	1	4868	8.4
5 to 9"	5 to 8.9"	2	8610	14.8
9 to 15"	9 to 20.9"	3	19022	32.8
15 to 21"				
21"+	21"+	4	834	1.4

The following rules were applied to assign SILC classes to SIMPPLLE states:

- The <5" SILC size class was assigned to the <5" size class in SIMPPLLE.
- The 5 to 8.9" SILC size class was assigned to the 5 to 9" size class in SIMPPLLE.
- The 9 to 20" SILC size class was assigned to either the 9 to 15" or 15 to 21" size class in SIMPPLLE. If the SILC class intersected with a majority TSMRS size class of 9 to 15" or less, the 9 to 20" SILC size class was assigned to the 9 to 15% class in SIMPPLLE. Similarly, if the SILC class intersected with a majority TSMRS canopy closure class of 15 to 21" or greater, the 9 to 20" SILC canopy closure class was assigned to the 15 to 21" size class in SIMPPLLE.
- The 21"+ SILC canopy closure was assigned to the 21"+ size class in SIMPPLLE.

Note that the percent of total area represented by SILC tree size classes sums to 57.4% of the assessment area. The percent of total area represented by the equivalent TSMRS tree size classes was 71% of the assessment area.

While aware of the SILC and TSMRS interaction effects in the reassignment process, we felt the bias was toward TSMRS. That is, in the context of this analysis the reassignment most likely favored SILC in that where the TSMRS size class was small, the SILC class was pushed to the smaller of two possible reassignments. The alternative was to randomly apportion the SILC class. We felt the application of prior knowledge was preferred and a best-case alternative given the difficulties of decomposition.

Table 58 lists the results of the SILC to SIMPPLLE reassignment. Visual comparisons of the original SILC distribution in Table 56 with the distribution in Table 58 support the effectiveness of this redistribution. The SILC class labels were seedling/sapling (<5"), pole (5 to 8.9"), medium (9 to 20.9"), and large/very-large (21"+). Table 57 identifies the corresponding size class labels for each SIMPPLLE structure-size class.

Table 57: Structure-size classes within SIMPPLLE and the associated size-class.

Structure-Size Class	SIMPPLE Definition	Size class
NF	Non-forest	N/A
NS	Non-stocked forest	N/A
SS	Seedling/sapling	<5"
POLE	Pole	5 to 9"
PMU	Multi-sized, with largest component pole-sized.	5 to 9"
MEDIUM	Medium	9 to 15"
MMU	Multi-sized, with largest component medium-sized.	9 to 15"
LARGE	Large	15 to 21"
LMU	Multi-sized, with largest component large-sized.	15 to 21"
VERY-LARGE	Very-large	21"+
MU	Multi-sized	N/A

Table 58: Acres and percent of total area for each structure-size class by source.

Structure-Size Class	Source					
	Photo-interpreted			Satellite TM imagery		
	Total acres	% of area	Mean Acres	Total acres	% of area	Mean Acres
NF	9349	16.1	29.7	9349	16.1	29.7
NS	10120	17.4	163.2	19328	33.3	58.9
SS	3705	6.4	22.3	3262	5.6	35.5
POLE	15792	27.2	31.6	6154	10.6	30.8
PMU	N/A	N/A	N/A	N/A	N/A	N/A
MEDIUM	4810	8.3	39.4	15322	26.4	33.6
MMU	25	<1.0	25.0	N/A	N/A	N/A
LARGE	5675	9.8	32.2	4581	7.9	32.0
LMU	1179	2.0	34.7	N/A	N/A	N/A
VERY-LARGE	137	<1.0	27.4	22	<1.0	22.0
MU	7308	12.6	46.2	82	<1.0	27.3

The analysis of variance T-test tests for differences in population means. The T-test results for each structure-size class by source (alpha = 0.05) are summarized in Table 59 and support the null hypothesis in all cases except for the seedling/sapling class. Each structure-size class was tested independent of other classes. We conclude that the sample means for acres by structure-size class were only significantly different between data sources for the seedling/sapling class. This represented a shift in the population mean for the seedling/sapling class to a collection of larger polygons with very little difference in total acres represented by this class.

Table 59: Pair-wise analysis of variance results for each structure-size class by source.

Source	Test	Probability	Significant
NF	Equal	1.0000	No
NS	Unequal	0.3158	No
SS	Unequal	0.0049	Yes
POLE	Unequal	0.7116	No
PMU	N/A	N/A	N/A
MEDIUM	Unequal	0.5092	No
MMU	N/A	N/A	N/A
LARGE	Equal	0.9457	No
LMU	N/A	N/A	N/A
VERY-LARGE	Equal	0.8999	No
MU	Equal	0.4536	No

A second test, a Likelihood-Ratio Chi-square test, tests for differences in frequency of occurrence. This is a robust 2 x 2 Test of Association

for structure-size classes by source (alpha = 0.05). Our null hypothesis stated there was no difference in the frequency of occurrence of a given structure-size class by source. Each structure-size class was tested independently and evaluated against the combined frequency of all other classes. The frequency and % of stand polygons in each class by source are presented in Table 60. The results of the Likelihood-Ratio Chi-square test for structure-size class are summarized in Table 61.

Table 60: Frequency and percent of total area for each structure-size class by source.

Species Type Class	Source			
	Photo-interpreted		Satellite TM imagery	
	N	% of stands	N	% of stands
NF	315	20.5	315	20.5
NS	62	4.0	328	21.3
SS	166	10.8	92	6.0
POLE	499	32.4	200	13.0
PMU	N/A	N/A	N/A	N/A
MEDIUM	122	7.9	456	29.6
MMU	1	<1.0	N/A	N/A
LARGE	176	11.4	143	9.3
LMU	34	2.2	N/A	N/A
VERY-LARGE	5	<1.0	1	<1.0
MU	158	10.3	3	<1.0

Table 61: Pair-wise Likelihood-Ratio Chi-squared test results for each structure-size class by source.

Canopy Closure Class	Probability	Significant
NF	1.000	No
NS	0.001	Yes
SS	0.001	Yes
POLE	0.001	Yes
PMU	N/A	N/A
MEDIUM	0.001	Yes
MMU	0.239	No
LARGE	0.051	No
LMU	0.001	Yes
VERY-LARGE	0.088	No
MU	0.001	Yes

The Chi-squared test supports rejection of the null hypothesis and we concluded that the frequency distributions for the non-stocked, seedling/sapling, pole, medium and multi-sized classes were

significantly different based on source. There was no significant difference in the frequency of occurrence of the large and very-large classes. In general, the SILC classification reversed the frequency of the pole and medium size classes over TSMRS, with SILC predicting more medium-sized and fewer pole-sized stands. The other significant shift was the increase in non-stocked stands. This is an artifact of the number of non-forest stands recognized by SILC. A number of TSMRS stands with cover-type and canopy class designations were classified as non-forest by SILC. Since we were constrained to existing states within SIMPPLLE, these non-forest SILC types were converted to non-stocked SIMPPLLE types. Given the relatively short simulation period of 5 decades, the non-forest versus non-stocked distinction may have been insignificant given the processes considered.

Analysis of Events by Source and Time Period given an Alternative Assignment of Structure-Size Class

The following tables summarize the event spectrum for each decade (t) for 100 simulations of the Stevensville West Central assessment area. Each event is summarized in four tables. The first table summarizes acres by period for the event. The second table provides the analysis of variance T-test results. The third table summarizes the frequency by period for the event. The fourth provides the Likelihood-Ratio Chi-squared test results. These four tables appear on the following pages for each of the following events:

- Succession or stand development
- Light severity fire
- Mixed severity fire
- Stand-replacing fire
- Light western spruce budworm
- Severe western spruce budworm
- Light mountain pine beetle in lodgepole pine
- Severe mountain pine beetle in lodgepole pine
- Mountain pine beetle in ponderosa pine
- Root disease
- Events that spread from a neighboring stand polygons
- Aggregation of severe events (includes stand-replacing fire, severe western spruce budworm, and severe mountain pine beetle)

The presentation of event tables concludes with an overall discussion on trends and interpretations.

Succession events

Table 62: Acres and percent of total area for succession events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Succession	1	47981.5	82.6	53431.2	92.0
Succession	2	47580.1	81.9	50336.5	86.6
Succession	3	46195.3	79.5	47581.4	81.9
Succession	4	43130.9	74.2	46443.9	79.9
Succession	5	41077.6	70.7	45327.7	78.0

Table 63: Pair-wise analysis of variance results for succession events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Succession	1	Unequal	0.0786	No
Succession	2	Unequal	0.3093	No
Succession	3	Equal	0.2343	No
Succession	4	Unequal	0.4103	No
Succession	5	Unequal	0.5147	No

Table 64: Frequency and percent of total area for succession events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Succession	1	1294.5	84.1	1396.5	90.8
Succession	2	1260.4	81.9	1308.2	85.1
Succession	3	1222.7	79.5	1230.5	80.0
Succession	4	1126.6	73.3	1192.9	77.6
Succession	5	1056.6	68.7	1149.9	74.8

Table 65: Pair-wise Likelihood-Ratio Chi-squared test results for succession events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Succession	1	0.001	Yes
Succession	2	0.001	Yes
Succession	3	0.001	Yes
Succession	4	0.001	Yes
Succession	5	0.001	Yes

Light-severity fire events

Table 66: Acres and percent of total area for light-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light-severity fire	1	284.2	<1.0	184.8	<1.0
Light-severity fire	2	233.6	<1.0	179.0	<1.0
Light-severity fire	3	247.1	<1.0	201.0	<1.0
Light-severity fire	4	331.4	<1.0	208.0	<1.0
Light-severity fire	5	335.5	<1.0	232.3	<1.0

Table 67: Pair-wise analysis of variance results for light-severity fire events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Light-severity fire	1	Unequal	0.0895	No
Light-severity fire	2	Unequal	0.6071	No
Light-severity fire	3	Unequal	0.4080	No
Light-severity fire	4	Unequal	0.5390	No
Light-severity fire	5	Unequal	0.6204	No

Table 68: Frequency and percent of total area for light-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light-severity fire	1	8.1	<1.0	5.8	<1.0
Light-severity fire	2	7.3	<1.0	5.4	<1.0
Light-severity fire	3	7.2	<1.0	6.2	<1.0
Light-severity fire	4	8.4	<1.0	5.7	<1.0
Light-severity fire	5	9.2	<1.0	6.6	<1.0

Table 69: Pair-wise Likelihood-Ratio Chi-squared test results for light-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Light-severity fire	1	0.001	Yes
Light-severity fire	2	0.001	Yes
Light-severity fire	3	0.009	Yes
Light-severity fire	4	0.001	Yes
Light-severity fire	5	0.001	Yes

Mixed-severity fire events

Table 70: Acres and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Mixed-severity fire	1	1800.1	3.1	1651.2	2.8
Mixed-severity fire	2	1368.5	2.4	1298.7	2.2
Mixed-severity fire	3	2201.6	3.8	1589.1	2.7
Mixed-severity fire	4	2613.8	4.5	1476.4	2.5
Mixed-severity fire	5	2361.5	4.1	1346.4	2.3

Table 71: Pair-wise analysis of variance results for mixed-severity fire events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Mixed-severity fire	1	Unequal	0.0001	Yes
Mixed-severity fire	2	Unequal	0.0001	Yes
Mixed-severity fire	3	Unequal	0.0001	Yes
Mixed-severity fire	4	Unequal	0.0001	Yes
Mixed-severity fire	5	Unequal	0.0001	Yes

Table 72: Frequency and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Mixed-severity fire	1	36.7	2.4	44.3	2.9
Mixed-severity fire	2	31.4	2.0	36.1	2.3
Mixed-severity fire	3	52.0	3.4	44.9	2.9
Mixed-severity fire	4	58.7	3.8	40.0	2.6
Mixed-severity fire	5	54.8	3.6	37.1	2.4

Table 73: Pair-wise Likelihood-Ratio Chi-squared test results for mixed-severity fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Mixed-severity fire	1	0.001	Yes
Mixed-severity fire	2	0.001	Yes
Mixed-severity fire	3	0.001	Yes
Mixed-severity fire	4	0.001	Yes
Mixed-severity fire	5	0.001	Yes

Stand-replacing fire events

Table 74: Acres and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Stand-replacing fire	1	1937.2	3.3	1708.6	2.9
Stand-replacing fire	2	1215.3	2.1	1358.0	2.3
Stand-replacing fire	3	1398.5	2.4	1529.5	2.6
Stand-replacing fire	4	1512.3	2.6	1244.2	2.1
Stand-replacing fire	5	1052.5	1.8	967.6	1.7

Table 75: Pair-wise analysis of variance results for stand-replacing fire events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Stand-replacing fire	1	Unequal	0.0001	Yes
Stand-replacing fire	2	Unequal	0.0001	Yes
Stand-replacing fire	3	Equal	0.5859	No
Stand-replacing fire	4	Unequal	0.4934	No
Stand-replacing fire	5	Unequal	0.0005	Yes

Table 76: Frequency and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Stand-replacing fire	1	52.7	3.4	55.9	3.6
Stand-replacing fire	2	32.6	2.1	42.0	2.7
Stand-replacing fire	3	37.7	2.5	41.7	2.7
Stand-replacing fire	4	39.9	2.6	33.3	2.2
Stand-replacing fire	5	29.9	1.9	24.9	1.6

Table 77: Pair-wise Likelihood-Ratio Chi-squared test results for stand-replacing fire events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Stand-replacing fire	1	0.001	Yes
Stand-replacing fire	2	0.001	Yes
Stand-replacing fire	3	0.001	Yes
Stand-replacing fire	4	0.001	Yes
Stand-replacing fire	5	0.001	Yes

Light western spruce budworm events

Table 78: Acres and percent of total area for light western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light budworm	1	5137.7	8.8	741.6	1.3
Light budworm	2	5155.7	8.9	3889.0	6.7
Light budworm	3	5467.3	9.4	5171.9	8.9
Light budworm	4	7091.4	12.2	6041.3	10.4
Light budworm	5	8912.0	15.3	6845.0	11.8

Table 79: Pair-wise analysis of variance results light western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Light budworm	1	Unequal	0.0001	Yes
Light budworm	2	Unequal	0.0001	Yes
Light budworm	3	Unequal	0.0001	Yes
Light budworm	4	Unequal	0.0001	Yes
Light budworm	5	Unequal	0.0001	Yes

Table 80: Frequency and percent of total area for light western spruce budworm by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light budworm	1	123.8	8.1	24.3	1.6
Light budworm	2	142.1	9.2	115.6	7.5
Light budworm	3	147.5	9.6	151.7	9.9
Light budworm	4	204.6	13.3	182.5	11.9
Light budworm	5	256.5	16.7	211.9	13.8

Table 81: Pair-wise Likelihood-Ratio Chi-squared test results for light western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Light budworm	1	0.001	Yes
Light budworm	2	0.001	Yes
Light budworm	3	0.010	Yes
Light budworm	4	0.001	Yes
Light budworm	5	0.001	Yes

Severe western spruce budworm events

Table 82: Acres and percent of total area for severe western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe budworm	1	852.1	1.5	117.7	<1.0
Severe budworm	2	2395.6	4.1	798.2	1.4
Severe budworm	3	2135.6	3.7	1819.5	3.1
Severe budworm	4	2794.9	4.8	2435.4	4.2
Severe budworm	5	3854.6	6.6	3019.5	5.2

Table 83: Pair-wise analysis of variance results for severe western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process Event	t	Test	Probability	Significant
Severe budworm	1	Unequal	0.0001	Yes
Severe budworm	2	Unequal	0.0001	Yes
Severe budworm	3	Unequal	0.0001	Yes
Severe budworm	4	Unequal	0.2613	No
Severe budworm	5	Unequal	0.1433	No

Table 84: Frequency and percent of total area for severe western spruce budworm by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe budworm	1	18.4	1.2	3.7	<1.0
Severe budworm	2	60.3	3.9	23.6	1.5
Severe budworm	3	59.5	3.9	55.0	3.6
Severe budworm	4	82.0	5.3	72.7	4.7
Severe budworm	5	116.7	7.6	93.4	6.1

Table 85: Pair-wise Likelihood-Ratio Chi-squared test results for severe western spruce budworm events by source and time period given an alternative assignment of structure-size class.

Process event	t	Probability	Significant
Severe budworm	1	0.001	Yes
Severe budworm	2	0.001	Yes
Severe budworm	3	0.001	Yes
Severe budworm	4	0.001	Yes
Severe budworm	5	0.001	Yes

Light mountain pine beetle events in lodgepole pine

Table 86: Acres and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light LPP beetle	1	30.0	<1.0	99.3	<1.0
Light LPP beetle	2	11.6	<1.0	72.6	<1.0
Light LPP beetle	3	34.0	<1.0	48.0	<1.0
Light LPP beetle	4	70.0	<1.0	23.6	<1.0
Light LPP beetle	5	42.9	<1.0	6.3	<1.0

Table 87: Pair-wise analysis of variance results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Light LPP beetle	1	Unequal	0.1435	No
Light LPP beetle	2	Unequal	0.4398	No
Light LPP beetle	3	Equal	0.0595	No
Light LPP beetle	4	Equal	0.6485	No
Light LPP beetle	5	Equal	0.8481	No

Table 88: Frequency and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light LPP beetle	1	0.7	<1.0	2.7	<1.0
Light LPP beetle	2	0.3	<1.0	1.8	<1.0
Light LPP beetle	3	0.8	<1.0	1.3	<1.0
Light LPP beetle	4	2.4	<1.0	0.9	<1.0
Light LPP beetle	5	1.5	<1.0	0.2	<1.0

Table 89: Pair-wise Likelihood-Ratio Chi-squared test results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Light LPP beetle	1	0.001	Yes
Light LPP beetle	2	0.001	Yes
Light LPP beetle	3	0.001	Yes
Light LPP beetle	4	0.001	Yes
Light LPP beetle	5	0.001	Yes

Severe mountain pine beetle events in lodgepole pine

Table 90: Acres and percent of total area for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe LPP beetle	1	9.8	<1.0	58.8	<1.0
Severe LPP beetle	2	5.4	<1.0	38.0	<1.0
Severe LPP beetle	3	9.0	<1.0	19.1	<1.0
Severe LPP beetle	4	39.2	<1.0	9.1	<1.0
Severe LPP beetle	5	22.0	<1.0	0.8	<1.0

Table 91: Pair-wise analysis of variance results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Severe LPP beetle	1	Unequal	0.4867	No
Severe LPP beetle	2	Unequal	0.5727	No
Severe LPP beetle	3	Equal	0.9627	No
Severe LPP beetle	4	Equal	0.1253	No
Severe LPP beetle	5	Unequal	0.0047	Yes

Table 92: Frequency and percent of total area of severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe LPP beetle	1	0.3	<1.0	1.6	<1.0
Severe LPP beetle	2	0.1	<1.0	1.1	<1.0
Severe LPP beetle	3	0.3	<1.0	0.6	<1.0
Severe LPP beetle	4	1.3	<1.0	0.4	<1.0
Severe LPP beetle	5	0.9	<1.0	0.1	<1.0

Table 93: Pair-wise Likelihood-Ratio Chi-squared test results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Severe LPP beetle	1	0.001	Yes
Severe LPP beetle	2	0.001	Yes
Severe LPP beetle	3	0.001	Yes
Severe LPP beetle	4	0.001	Yes
Severe LPP beetle	5	0.001	Yes

Mountain pine beetle events in ponderosa pine

Table 94: Acres and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
PP beetle	1	36.2	<1.0	106.8	<1.0
PP beetle	2	54.1	<1.0	115.2	<1.0
PP beetle	3	144.0	<1.0	82.6	<1.0
PP beetle	4	222.2	<1.0	110.5	<1.0
PP beetle	5	124.7	<1.0	86.4	<1.0

Table 95: Pair-wise analysis of variance results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
PP beetle	1	Unequal	0.0001	Yes
PP beetle	2	Unequal	0.0490	Yes
PP beetle	3	Unequal	0.8487	No
PP beetle	4	Unequal	0.5892	No
PP beetle	5	Unequal	0.6936	No

Table 96: Frequency and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
PP beetle	1	1.8	<1.0	3.2	<1.0
PP beetle	2	1.3	<1.0	3.6	<1.0
PP beetle	3	3.9	<1.0	2.2	<1.0
PP beetle	4	6.8	<1.0	3.5	<1.0
PP beetle	5	3.6	<1.0	2.6	<1.0

Table 97: Pair-wise Likelihood-Ratio Chi-squared test results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
PP beetle	1	0.001	Yes
PP beetle	2	0.001	Yes
PP beetle	3	0.001	Yes
PP beetle	4	0.001	Yes
PP beetle	5	0.001	Yes

Root disease events

Table 98: Acres and percent of total area for root disease events by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Root disease	1	31.2	<1.0	0.0	0.0
Root disease	2	80.1	<1.0	14.8	<1.0
Root disease	3	267.6	<1.0	57.9	<1.0
Root disease	4	293.9	<1.0	107.6	<1.0
Root disease	5	316.7	<1.0	268.0	<1.0

Table 99: Pair-wise analysis of variance results root disease events by source and time period given an alternative assignment of structure-size class.

Process Event	t	Test	Probability	Significant
Root disease	1	N/A	N/A	N/A
Root disease	2	Unequal	0.0001	Yes
Root disease	3	Unequal	0.0001	Yes
Root disease	4	Unequal	0.0001	Yes
Root disease	5	Unequal	0.0001	Yes

Table 100: Frequency and percent of total area for root disease events by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Root disease	1	1.0	<1.0	0.0	0.0
Root disease	2	2.2	<1.0	0.6	<1.0
Root disease	3	6.4	<1.0	3.9	<1.0
Root disease	4	7.3	<1.0	6.1	<1.0
Root disease	5	8.3	<1.0	11.3	<1.0

Table 101: Pair-wise Likelihood-Ratio Chi-squared test results for root disease events by source and time period given an alternative assignment of structure-size class.

Process event	t	Probability	Significant
Root disease	1	0.001	Yes
Root disease	2	0.001	Yes
Root disease	3	0.001	Yes
Root disease	4	0.001	Yes
Root disease	5	0.001	Yes

Events spread from neighbors

Table 102: Acres and percent of total area for events spread from neighbor by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Spread from neighbor	1	5148.3	8.9	2869.2	4.9
Spread from neighbor	2	3068.0	5.3	3085.2	5.3
Spread from neighbor	3	3619.9	6.2	3593.8	6.2
Spread from neighbor	4	4561.5	7.9	3173.2	5.5
Spread from neighbor	5	4564.3	7.9	2972.1	5.1

Table 103: Pair-wise analysis of variance results for events spread from neighbor by source and time period given an alternative assignment of structure-size class.

Process Event	t	Test	Probability	Significant
Spread from neighbor	1	Unequal	0.0001	Yes
Spread from neighbor	2	Unequal	0.0001	Yes
Spread from neighbor	3	Unequal	0.0001	Yes
Spread from neighbor	4	Unequal	0.0001	Yes
Spread from neighbor	5	Unequal	0.0001	Yes

Table 104: Frequency and percent of total area for events spread from neighbor by source and time period given an alternative assignment of structure-size class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Spread from neighbor	1	113.3	7.4	85.5	5.6
Spread from neighbor	2	80.6	5.2	90.0	5.9
Spread from neighbor	3	90.1	5.9	98.7	6.4
Spread from neighbor	4	111.2	7.2	85.0	5.5
Spread from neighbor	5	117.5	7.6	82.7	5.4

Table 105: Pair-wise Likelihood-Ratio Chi-squared test results for events spread from neighbor by source and time period given an alternative assignment of structure-size class.

Process event	t	Probability	Significant
Spread from neighbor	1	0.001	Yes
Spread from neighbor	2	0.001	Yes
Spread from neighbor	3	0.001	Yes
Spread from neighbor	4	0.001	Yes
Spread from neighbor	5	0.001	Yes

Severe events

Table 106: Acres and percent of total area for severe events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe events	1	2799.1	4.8	1885.1	3.2
Severe events	2	3616.3	6.2	2194.1	3.8
Severe events	3	3543.1	6.1	3367.8	5.8
Severe events	4	4346.4	7.5	3688.8	6.3
Severe events	5	4929.2	8.5	3987.9	6.9

Table 107: Pair-wise analysis of variance results for severe events by source and time period given an alternative assignment of structure-size class.

Process Event	*t*	Test	Probability	Significant
Severe events	1	Unequal	0.0001	Yes
Severe events	2	Unequal	0.0001	Yes
Severe events	3	Unequal	0.0004	Yes
Severe events	4	Unequal	0.1687	No
Severe events	5	Unequal	0.5104	No

Table 108: Frequency and percent of total area for severe events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe events	1	71.3	4.6	61.2	4.0
Severe events	2	93.0	6.0	66.6	4.3
Severe events	3	97.5	6.3	97.3	6.3
Severe events	4	123.2	8.0	106.5	6.9
Severe events	5	147.5	9.6	118.3	7.7

Table 109: Pair-wise Likelihood-Ratio Chi-squared test results for severe events by source and time period given an alternative assignment of structure-size class.

Process event	*t*	Probability	Significant
Severe events	1	0.001	Yes
Severe events	2	0.001	Yes
Severe events	3	0.859	No
Severe events	4	0.001	Yes
Severe events	5	0.001	Yes

Overall Event Summary for Structure-size Classes

Table 110 provides a summary of event outcomes given an alternative assignment of structure-size class from SILC. The 'Signif. Periods' column identifies the number of periods out of 5 where the statistical test was significant (null hypothesis rejected). The 'Trend' column indicates that the direction of change was increasing (+), decreasing (-) or modulating (±) across periods. An increase was interpreted as a net gain across periods, a decrease as a net loss across periods, and a modulation as compensating net gains and net losses across periods but with a redistribution as to when events occur among periods.

Table 110: Summary of event outcomes given an alternative assignment of structure-size class.

Process event	Test Summary			
	Analysis of Variance on acres		Frequency of occurrence	
	Signif. Periods	Trend	Signif. Periods	Trend
Succession	0		5	+
Light-severity fire	0		5	-
Mixed-severity fire	5	-	5	-
Stand-replacing fire	3	±	5	±
Light budworm	5	-	5	-
Severe budworm	3	-	5	-
Light LPP beetle	0		5	±
Severe LPP beetle	1	±	5	±
PP beetle	2	±	5	±
Root disease	4	-	5	+
Spread from neighbor	5	-	5	-
Severe events	3	-	4	-

We conclude that the sample mean acres by period for all events except for succession, light-severity fire and light LPP beetle were significantly different between sources given an alternative assignment of structure-size class. In all cases, there was a decrease in the mean for each event. The frequencies of all events were significantly different between sources given an alternative assignment of structure-size class. There was an increase in the frequency of succession and root disease. There was a decrease in the frequency of light- and mixed-severity fires, budworm, spread and severe events. Severe events like severe LPP beetle and PP beetle exhibited a trend that was inverse of

the TSMRS data. That is, the TSMRS data generally indicated an increasing frequency of occurrence in these events, while the SILC data showed a decreasing frequency over time. The overall decrease in mean acres and frequency of events was most likely related to a redistribution of structure-size classes. The SILC data identified significantly more medium-sized stands but did not increase the number of major events, as one would expect. However, it did push severe events into earlier periods. The increase in root disease was probably related to a reduction in other events and not a significant consideration within this assessment area.

Scenario III: Analysis of an Alternative Assignment of Species-type Class.

The objective of this scenario was to test differences in event outcomes given a change in species-type class with canopy closure, structure-size class, and spatial arrangement held constant. An independent estimate of species-type (cover-type) was derived from the TSMRS database and satellite TM imagery for the same geographic location. Our null hypothesis stated that there was no real difference in the sample mean acres or frequency distribution of events for a given species-type class based on data source alone. Source was the independent variable.

A rejection of the null hypothesis was interpreted as an interaction of a change in landscape composition (change in frequency of species-type classes) and/or a change in spatial configuration (spatial redistribution) since the population of stand polygons does not change. It was possible for the null hypothesis to be true and spatial configuration to be different, but we did not specifically test or quantify a change in spatial configuration. Testing for changes in spatial configuration was beyond the scope of this analysis.

The species classification for SIMPPLLE was quite different from SILC categories making the reassignment of SILC cover-type to TSMRS polygons quite complex. As discussed earlier in this report, SILC represented a coarser classification of the same landscape. This was supported by the fact that there were 19 SILC cover-types and 31 SIMPPLLE (TSMRS) cover-types representing the same geographic area. Any rule set for translating SILC cover-types to SIMMPPLE states will result

in a more generalized landscape, particularly if SILC is driving the translation. There was considerable concern over the elimination of minor types in the context of process. This may be the tradeoff we must accept when moving to coarser classifications over larger extents. The SIMPPLLE specie labels and specie names are listed below in Table 111.

Table 111: SIMPPLLE specie labels and specie names.

SIMPPLLE species label	Species name
AF	Subalpine fir
AL	Alpine larch
CW	Cottonwood
DF	Douglas-fir
ES	Englemann spruce
GF	Grand-fir
L	Western larch
LP	Lodgepole pine
MC	Mixed-confier
NF	Non-forest
NS	Non-stocked
PP	Ponderosa pine
QA	Quaking aspen
WB	Whitebark pine

The mapping of SILC cover-types to states within SIMPPLLE was based on a correspondence matrix for all types within a given potential vegetation class. The correspondence matrix was built from the intersection of TSMRS polygons with SILC polygons. Each correspondence matrix lists the percent of a SILC cover-type within each SIMPPLLE cover-type, and the frequency of occurrence. A portion of a correspondence table for potential vegetation Group A appears in Table 220 in Appendix A: SILC Cover-type to SIMPPLLE State Reassignments. The reclassification table was built from interpreting these correspondence matrices. The full reclassification table appears in Table 221 of Appendix A. A portion of this table appears in Table 213.

The reassignment table shows the reclassification options considered. The first option was a direct assignment of SILC to a state within SIMPPLLE. This was not a viable option due to many atypical combinations such as western red cedar (*Thuja plicata*) on a warm/dry potential vegetation type. These atypical combinations had no representation within existing states in SIMPPLLE. The second option was a reclassification of SILC cover-types to SIMPPLLE states using the correspondence matrices presented earlier. Primary and secondary

reassignments were defined by the dominant and co-dominant SIMPPLLE state for a given SILC cover-type within a potential vegetation group. A SIMPPLLE state was assigned to each TSMRS polygon from this table based on the majority SILC cover-type value within the TSMRS polygon, and the TSMRS potential vegetation class for the polygon. Only the primary reassignments were considered in reassignment. The reassigned cover-type value can be interpreted as the most-likely TSMRS/SIMPPLLE vegetation group given the corresponding and majority SILC cover-type value for any given TSMRS polygon. For reference, Table 112 summarizes the acres of each original SILC forest cover-type within the Stevensville West Central assessment area. Table 114 shows the acres and percent of total area for each species-type class by source that resulted from the reclassification process.

Table 112: Acres by SILC forest cover-type for the Stevensville West Central assessment area.

SILC forest cover-type Code	Cover-type name	Acres represented by cover-type
4102	Boadleaf forest	4108.1
4201	Englemann spruce	211.2
4203	Lodgepole pine	3776.6
4206	Ponderosa pine	3542.3
4207	Grand fir	1065.0
4208	Subalpine fir	2676.3
4210	Western red-cedar	43.7
4212	Douglas-fir	3110.0
4215	Western larch	130.7
4219	Mixed whitebark pine	1219.6
4220	Mixed subalpine	6155.3
4221	Mixed mesic	3747.1
4222	Mixed xeric	1680.6
4223	Douglas-fir/lodgepole pine	530.8
4225	Douglas-fir/grand-fir	501.4
4226	Western red-cedar/grand fir	168.1
4228	Western larch/lodgepole pine	277.9
4229	Western larch/Douglas-fir	119.0
4301	Mixed needleleaf/broadleaf	249.9
	all other non-forest types	24696.0

Table 113: SILC cover-type to SIMPPLLE state reassignment for potential vegetation Group A.

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-A	2000	AGR	PP-DF	NS
WMT-A	3101	NS	NS	PP
WMT-A	3102	NS	PP	PP-DF
WMT-A	3104	NS	NS	PP
WMT-A	3202	NS	PP-DF	PP
WMT-A	3306	NS	PP-DF	
WMT-A	4102	*	PP	NS
WMT-A	4203	*	PP	PP-DF
WMT-A	4206	PP	PP	PP-DF
WMT-A	4207	*	PP	NS
WMT-A	4208	*	NS	
WMT-A	4212	DF	PP	PP-DF
WMT-A	4220	*	PP	NS
WMT-A	4221	*	PP	
WMT-A	4222	PP-DF	PP	PP-DF
WMT-A	4223	DF	PP-DF	
WMT-A	4225	DF	PP	NS
WMT-A	4226	*	PP	
WMT-A	4229	*	PP	
WMT-A	7300	NF	NS	PP
WMT-A	7800	NF	PP	NS

Table 114: Acres and percent of total area for each species-type class by source.

Species-type Class	Source					
	Photo-interpreted			Satellite TM imagery		
	Total acres	% of area	Mean acres	Total acres	% of area	Mean Acres
AF	3405	5.9	31.8	518	<1.0	34.5
AL	2142	3.7	25.8	2791	4.8	29.1
CW	269	<1.0	26.9	0	0.0	0.0
CW-MC	523	<1.0	74.4	30	<1.0	15.0
DF	5659	9.7	37.7	2668	4.6	27.2
DF-GF	11	0.02	11.0	0	0.0	0.0
DF-LP	169	<1.0	24.1	0	0.0	0.0
DF-LP-AF	136	<1.0	19.4	0	0.0	0.0
DF-PP-GF	562	1.0	28.1	858	1.5	30.6
ES-AF	454	<1.0	37.8	71	<1.0	23.7
GF	71	<1.0	35.5	0	0.0	0.0
L	90	<1.0	18.0	0	0.0	0.0
L-DF	1111	1.9	25.8	336	<1.0	22.4
L-DF-AF	6318	10.9	35.1	6721	11.6	35.0
L-DF-GF	631	1.1	19.7	1333	2.3	23.4
L-DF-PP	337	<1.0	37.4	0	0.0	0.0
L-DF-PP-LP	66	<1.0	66.0	0	0.0	0.0
L-LP	125	<1.0	62.5	56	<1.0	56.0
L-LP-DF-AF	330	<1.0	82.5	209	<1.0	23.2
L-LP-DF-GF	174	<1.0	21.8	108	<1.0	36.0
L-PP	206	<1.0	29.4	0	0.0	0.0
L-PP-LP	74	<1.0	37.0	0	0.0	0.0
LP	1497	2.6	31.2	3053	5.3	33.9
NF	9448	16.3	30.0	9322	16.0	29.7
NS	10146	17.5	161.1	13263	22.8	115.3
PP	663	1.1	20.7	704	1.2	29.3
PP-DF	10157	17.5	35.3	10787	18.6	34.0
QA	40	<1.0	40.0	0	0.0	0.0
QA-MC	198	<1.0	49.5	0	0.0	0.0
WB	3088	5.3	35.1	758	1.3	27.1

The analysis of variance T-test tested for differences in population means. The T-test results for each species-type class by source (alpha = 0.05) are summarized in Table 115 and support the null hypothesis. Rows containing the 'N/A' label were not represented in the reassignment process because they did not have a dominant presence within any SILC type in the correspondence tables. Each species-type class was tested independent of other classes. We conclude that the sample means for acres by species-type class were only significantly different between data sources for the L-LP-DF-AF species-type class. This represents a

shift in the population mean for the L-LP-DF-AF species-type to a collection of smaller polygons and only a slight reduction in the total acres for this species-type.

Table 115: Pair-wise analysis of variance results for each species-type class by source.

Source	Test	Probability	Significant
AF	Equal	0.7647	No
AL	Unequal	0.3698	No
CW	N/A	N/A	N/A
CW-MC	Equal	0.2006	No
DF	Unequal	0.1632	No
DF-GF	N/A	N/A	N/A
DF-LP	N/A	N/A	N/A
DF-LP-AF	N/A	N/A	N/A
DF-PP-GF	Equal	0.7479	No
ES-AF	Equal	0.5382	No
GF	N/A	N/A	N/A
L	N/A	N/A	N/A
L-DF	Equal	0.6585	No
L-DF-AF	Equal	0.9771	No
L-DF-GF	Unequal	0.4150	No
L-DF-PP	N/A	N/A	N/A
L-DF-PP-LP	N/A	N/A	N/A
L-LP	Equal	0.6667	No
L-LP-DF-AF	Equal	0.0097	Yes
L-LP-DF-GF	Equal	0.4882	No
L-PP	N/A	N/A	N/A
L-PP-LP	N/A	N/A	N/A
LP	Equal	0.6548	No
NF	Equal	0.9100	No
NS	Unequal	0.6893	No
PP	Unequal	0.3165	No
PP-DF	Equal	0.6611	No
QA	N/A	N/A	N/A
QA-MC	N/A	N/A	N/A
WB	Unequal	0.0947	No

Table 116: Frequency and percent of total area for each species-type class by source.

Species Type Class	Source			
	Photo-interpreted		Satellite TM imagery	
	N	% of stands	N	% of stands
AF	107	7.0	15	1.0
AL	83	5.4	96	6.2
CW	10	<1.0	0	0.0
CW-MC	7	<1.0	2	<1.0
DF	150	9.8	98	6.4
DF-GF	1	<1.0	0	0.0
DF-LP	7	<1.0	0	0.0
DF-LP-AF	7	<1.0	0	0.0
DF-PP-GF	20	1.3	28	1.8
ES-AF	12	<1.0	3	<1.0
GF	2	<1.0	0	0.0
L	5	<1.0	0	0.0
L-DF	43	2.8	15	1.0
L-DF-AF	180	11.7	192	12.5
L-DF-GF	32	2.1	57	3.7
L-DF-PP	9	<1.0	0	0.0
L-DF-PP-LP	1	<1.0	0	0.0
L-LP	2	<1.0	1	<1.0
L-LP-DF-AF	4	<1.0	9	<1.0
L-LP-DF-GF	8	<1.0	3	<1.0
L-PP	7	<1.0	0	0.0
L-PP-LP	2	<1.0	0	0.0
LP	48	3.1	90	5.9
NF	315	20.5	314	20.4
NS	63	4.1	115	7.5
PP	32	2.1	24	1.6
PP-DF	288	18.7	317	20.6
QA	1	<1.0	0	0.0
QA-MC	4	<1.0	0	0.0
WB	88	5.7	28	1.8

A second test, a Likelihood-Ratio Chi-square test, tests for differences in frequency of occurrence. This is a robust 2 x 2 Test of Association for species-type classes by source (alpha = 0.05). Our null hypothesis stated that there was no difference in the frequency of occurrence of a given species-type class by source. Each species-type class is tested independently and evaluated against the combined frequency of all other classes. The frequency and % of stand polygons in each class by source are presented in Table 116. The results of the Likelihood-Ratio Chi-square test for structure-size class are summarized in Table 117.

Table 117: Pair-wise Likelihood-Ratio Chi-squared test results for each species-type class by source.

Canopy Closure Class	Probability	Significant
AF	0.001	Yes
AL	0.317	No
CW	0.001	Yes
CW-MC	0.086	No
DF	0.001	Yes
DF-GF	0.239	No
DF-LP	0.002	Yes
DF-LP-AF	0.002	Yes
DF-PP-GF	0.243	No
ES-AF	0.016	Yes
GF	0.096	No
L	0.008	Yes
L-DF	0.001	Yes
L-DF-AF	0.507	No
L-DF-GF	0.007	Yes
L-DF-PP	0.001	Yes
L-DF-PP-LP	0.239	No
L-LP	0.560	No
L-LP-DF-AF	0.159	No
L-LP-DF-GF	0.124	No
L-PP	0.002	Yes
L-PP-LP	0.096	No
LP	0.001	Yes
NF	0.964	No
NS	0.001	Yes
PP	0.280	No
PP-DF	0.188	No
QA	0.239	No
QA-MC	0.018	Yes
WB	0.001	Yes

The Chi-squared test supported rejection of the null hypothesis and we conclude the frequency distributions for the AF, CW, DF, DF-LP, DF-LP-

AF, ES-AF, L, L-DF, L-DF-GF, L-DF-PP, L-PP, LP, NS, QA-MC and WB species-types were significantly different based on source. There was no significant difference in the frequency of occurrence of the AL, CW-MC, DF-GF, DF-PP-GF, GF, L-DF-AF, L-DF-PP-LP, L-LP, L-LP-DF-AF, L-LP-DF-GF, L-PP-LP, NF, PP, PP-DF and QA species-types. In general, the SILC re-classification indicated a higher frequency and more acres of fewer cover-types than exhibited in TSMRS. Given there was essentially no difference in population means, we assumed the re-assignment of types based on SILC resulted in a redistribution of types. Based on total acres, Table 114 and Table 116 show an increase in mixed types and LP, a reduction in high-elevation types like AF and WB, and a significant reduction in DF. The event spectrum should reflect the results of this shift in the proportion of DF and LP are host species.

Analysis of Events by Source and Time Period given an Alternative Assignment of Species-type Class

The following tables summarize the event spectrum for each decade (t) for 100 simulations of the Stevensville West Central assessment area. Each event is summarized in four tables. The first table summarizes acres by period for the event. The second table provides the analysis of variance T-test results. The third table summarizes the frequency by period for the event. The fourth provides the Likelihood-Ratio Chi-squared test results. These four tables appear on the following pages for each of the following events:

- Succession or stand development
- Light severity fire
- Mixed severity fire
- Stand-replacing fire
- Light western spruce budworm
- Severe western spruce budworm
- Light mountain pine beetle in lodgepole pine
- Severe mountain pine beetle in lodgepole pine
- Mountain pine beetle in ponderosa pine
- Root disease
- Events that spread from a neighboring stand polygons
- Aggregation of severe events (includes stand-replacing fire, severe western spruce budworm, and severe mountain pine beetle)

The presentation of event tables conclude with an overall discussion on trends and interpretations.

Succession events

Table 118: Acres and percent of total area for succession events by source and time period given an alternative assignment of species-type class.

Process event	*T*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Succession	1	47981.5	82.6	48723.7	83.7
Succession	2	47580.1	81.9	47959.7	82.5
Succession	3	46195.3	79.5	47366.7	81.5
Succession	4	43130.9	74.2	44667.1	76.9
Succession	5	41077.6	70.7	42278.9	72.8

Table 119: Pair-wise analysis of variance results for succession events by source and time period given an alternative assignment of species-type class.

Process Event	*T*	Test	Probability	Significant
Succession	1	Equal	0.7365	No
Succession	2	Equal	0.7283	No
Succession	3	Equal	0.5284	No
Succession	4	Equal	0.6027	No
Succession	5	Equal	0.6774	No

Table 120: Frequency and percent of total area for succession events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Succession	1	1294.5	84.1	1306.3	84.9
Succession	2	1260.4	81.9	1262.0	82.1
Succession	3	1222.7	79.5	1238.3	80.5
Succession	4	1126.6	73.3	1154.2	75.0
Succession	5	1056.6	68.7	1077.6	70.1

Table 121: Pair-wise Likelihood-Ratio Chi-squared test results for succession events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Succession	1	0.001	Yes
Succession	2	0.447	No
Succession	3	0.001	Yes
Succession	4	0.001	Yes
Succession	5	0.001	Yes

Light-severity fire events

Table 122: Acres and percent of total area for light-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light-severity fire	1	284.2	<1.0	239.6	<1.0
Light-severity fire	2	233.6	<1.0	223.1	<1.0
Light-severity fire	3	247.1	<1.0	239.8	<1.0
Light-severity fire	4	331.4	<1.0	256.9	<1.0
Light-severity fire	5	335.5	<1.0	264.6	<1.0

Table 123: Pair-wise analysis of variance results for light-severity fire events by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Light-severity fire	1	Equal	0.3444	No
Light-severity fire	2	Unequal	0.4896	No
Light-severity fire	3	Unequal	0.6723	No
Light-severity fire	4	Unequal	0.4225	No
Light-severity fire	5	Unequal	0.1454	No

Table 124: Frequency and percent of total area for light-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light-severity fire	1	8.1	<1.0	7.2	<1.0
Light-severity fire	2	7.3	<1.0	6.6	<1.0
Light-severity fire	3	7.2	<1.0	7.2	<1.0
Light-severity fire	4	8.4	<1.0	7.1	<1.0
Light-severity fire	5	9.2	<1.0	8.1	<1.0

Table 125: Pair-wise Likelihood-Ratio Chi-squared test results for light-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Light-severity fire	1	0.017	Yes
Light-severity fire	2	0.085	No
Light-severity fire	3	0.958	No
Light-severity fire	4	0.001	Yes
Light-severity fire	5	0.008	Yes

Mixed-severity fire events

Table 126: Acres and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Mixed-severity fire	1	1800.1	3.1	1575.4	2.7
Mixed-severity fire	2	1368.5	2.4	1445.0	2.5
Mixed-severity fire	3	2201.6	3.8	1720.5	3.0
Mixed-severity fire	4	2613.8	4.5	1953.8	3.4
Mixed-severity fire	5	2361.5	4.1	1948.2	3.4

Table 127: Pair-wise analysis of variance results for mixed-severity fire events by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Mixed-severity fire	1	Unequal	0.3319	No
Mixed-severity fire	2	Unequal	0.6561	No
Mixed-severity fire	3	Unequal	0.0035	Yes
Mixed-severity fire	4	Unequal	0.0001	Yes
Mixed-severity fire	5	Unequal	0.0006	Yes

Table 128: Frequency and percent of total area for mixed-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Mixed-severity fire	1	36.7	2.4	34.6	2.2
Mixed-severity fire	2	31.4	2.0	33.6	2.2
Mixed-severity fire	3	52.0	3.4	43.9	2.9
Mixed-severity fire	4	58.7	3.8	50.4	3.3
Mixed-severity fire	5	54.8	3.6	50.0	3.3

Table 129: Pair-wise Likelihood-Ratio Chi-squared test results for mixed-severity fire events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Mixed-severity fire	1	0.012	Yes
Mixed-severity fire	2	0.006	Yes
Mixed-severity fire	3	0.001	Yes
Mixed-severity fire	4	0.001	Yes
Mixed-severity fire	5	0.001	Yes

Stand-replacing fire events

Table 130: Acres and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Stand-replacing fire	1	1937.2	3.3	1686.1	2.9
Stand-replacing fire	2	1215.3	2.1	1311.7	2.3
Stand-replacing fire	3	1398.5	2.4	1094.7	1.9
Stand-replacing fire	4	1512.3	2.6	1265.1	2.2
Stand-replacing fire	5	1052.5	1.8	1064.6	1.8

Table 131: Pair-wise analysis of variance results for stand-replacing fire events by source and time period given an alternative assignment of species-type class.

Process Event	t	Test	Probability	Significant
Stand-replacing fire	1	Unequal	0.3294	No
Stand-replacing fire	2	Equal	0.0165	Yes
Stand-replacing fire	3	Unequal	0.3706	No
Stand-replacing fire	4	Unequal	0.6812	No
Stand-replacing fire	5	Unequal	0.5547	No

Table 132: Frequency and percent of total area for stand-replacing fire events by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Stand-replacing fire	1	52.7	3.4	45.1	2.9
Stand-replacing fire	2	32.6	2.1	33.6	2.2
Stand-replacing fire	3	37.7	2.5	30.1	2.0
Stand-replacing fire	4	39.9	2.6	33.7	2.2
Stand-replacing fire	5	29.9	1.9	29.8	1.9

Table 133: Pair-wise Likelihood-Ratio Chi-squared test results for stand-replacing fire events by source and time period given an alternative assignment of species-type class.

Process event	t	Probability	Significant
Stand-replacing fire	1	0.001	Yes
Stand-replacing fire	2	0.219	No
Stand-replacing fire	3	0.001	Yes
Stand-replacing fire	4	0.001	Yes
Stand-replacing fire	5	0.886	No

Light western spruce budworm events

Table 134: Acres and percent of total area for light western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light budworm	1	5137.7	8.8	4821.6	8.3
Light budworm	2	5155.7	8.9	4814.6	8.3
Light budworm	3	5467.3	9.4	4984.8	8.6
Light budworm	4	7091.4	12.2	6693.7	11.5
Light budworm	5	8912.0	15.3	8080.5	13.9

Table 135: Pair-wise analysis of variance results light western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Light budworm	1	Unequal	0.1316	No
Light budworm	2	Unequal	0.0037	Yes
Light budworm	3	Unequal	0.0001	Yes
Light budworm	4	Unequal	0.6505	No
Light budworm	5	Unequal	0.0250	Yes

Table 136: Frequency and percent of total area for light western spruce budworm by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light budworm	1	123.8	8.1	118.4	7.7
Light budworm	2	142.1	9.2	137.1	8.9
Light budworm	3	147.5	9.6	142.6	9.3
Light budworm	4	204.6	13.3	192.1	12.5
Light budworm	5	256.5	16.7	238.1	15.5

Table 137: Pair-wise Likelihood-Ratio Chi-squared test results for light western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Light budworm	1	0.001	Yes
Light budworm	2	0.002	Yes
Light budworm	3	0.003	Yes
Light budworm	4	0.001	Yes
Light budworm	5	0.001	Yes

Severe western spruce budworm events

Table 138: Acres and percent of total area for severe western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe budworm	1	852.1	1.5	828.2	1.4
Severe budworm	2	2395.6	4.1	2098.8	3.6
Severe budworm	3	2135.6	3.7	2103.8	3.6
Severe budworm	4	2794.9	4.8	2562.5	4.4
Severe budworm	5	3854.6	6.6	3786.2	6.5

Table 139: Pair-wise analysis of variance results for severe western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Severe budworm	1	Unequal	0.7670	No
Severe budworm	2	Unequal	0.0001	Yes
Severe budworm	3	Unequal	0.3185	No
Severe budworm	4	Unequal	0.0048	Yes
Severe budworm	5	Unequal	0.7815	No

Table 140: Frequency and percent of total area for severe western spruce budworm by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe budworm	1	18.4	1.2	18.1	1.2
Severe budworm	2	60.3	3.9	57.5	3.7
Severe budworm	3	59.5	3.9	59.7	3.9
Severe budworm	4	82.0	5.3	78.6	5.1
Severe budworm	5	116.7	7.6	114.2	7.4

Table 141: Pair-wise Likelihood-Ratio Chi-squared test results for severe western spruce budworm events by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Severe budworm	1	0.571	No
Severe budworm	2	0.008	Yes
Severe budworm	3	0.844	No
Severe budworm	4	0.006	Yes
Severe budworm	5	0.086	No

Light mountain pine beetle events in lodgepole pine

Table 142: Acres and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light LPP beetle	1	30.0	<1.0	72.9	<1.0
Light LPP beetle	2	11.6	<1.0	27.2	<1.0
Light LPP beetle	3	34.0	<1.0	37.2	<1.0
Light LPP beetle	4	70.0	<1.0	87.5	<1.0
Light LPP beetle	5	42.9	<1.0	60.9	<1.0

Table 143: Pair-wise analysis of variance results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Light LPP beetle	1	Unequal	0.2204	No
Light LPP beetle	2	Equal	0.4968	No
Light LPP beetle	3	Unequal	0.1826	No
Light LPP beetle	4	Equal	0.5468	No
Light LPP beetle	5	Equal	0.9732	No

Table 144: Frequency and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light LPP beetle	1	0.7	<1.0	2.0	<1.0
Light LPP beetle	2	0.3	<1.0	0.8	<1.0
Light LPP beetle	3	0.8	<1.0	1.0	<1.0
Light LPP beetle	4	2.4	<1.0	3.2	<1.0
Light LPP beetle	5	1.5	<1.0	2.1	<1.0

Table 145: Pair-wise Likelihood-Ratio Chi-squared test results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Light LPP beetle	1	0.001	Yes
Light LPP beetle	2	0.001	Yes
Light LPP beetle	3	0.095	No
Light LPP beetle	4	0.001	Yes
Light LPP beetle	5	0.001	Yes

Severe mountain pine beetle events in lodgepole pine

Table 146: Acres and percent of total area for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe LPP beetle	1	9.8	<1.0	48.4	<1.0
Severe LPP beetle	2	5.4	<1.0	20.6	<1.0
Severe LPP beetle	3	9.0	<1.0	23.6	<1.0
Severe LPP beetle	4	39.2	<1.0	71.8	<1.0
Severe LPP beetle	5	22.0	<1.0	46.6	<1.0

Table 147: Pair-wise analysis of variance results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
Severe LPP beetle	1	Unequal	0.9755	No
Severe LPP beetle	2	Unequal	0.4185	No
Severe LPP beetle	3	Unequal	0.1458	No
Severe LPP beetle	4	Equal	0.9869	No
Severe LPP beetle	5	Equal	0.3310	No

Table 148: Frequency and percent of total area of severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe LPP beetle	1	0.3	<1.0	1.2	<1.0
Severe LPP beetle	2	0.1	<1.0	0.5	<1.0
Severe LPP beetle	3	0.3	<1.0	0.6	<1.0
Severe LPP beetle	4	1.3	<1.0	2.4	<1.0
Severe LPP beetle	5	0.9	<1.0	1.6	<1.0

Table 149: Pair-wise Likelihood-Ratio Chi-squared test results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
Severe LPP beetle	1	0.001	Yes
Severe LPP beetle	2	0.001	Yes
Severe LPP beetle	3	0.004	Yes
Severe LPP beetle	4	0.001	Yes
Severe LPP beetle	5	0.001	Yes

Mountain pine beetle events in ponderosa pine

Table 150: Acres and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
PP beetle	1	36.2	<1.0	28.8	<1.0
PP beetle	2	54.1	<1.0	67.1	<1.0
PP beetle	3	144.0	<1.0	197.0	<1.0
PP beetle	4	222.2	<1.0	177.9	<1.0
PP beetle	5	124.7	<1.0	110.3	<1.0

Table 151: Pair-wise analysis of variance results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of species-type class.

Process Event	*t*	Test	Probability	Significant
PP beetle	1	Equal	0.1285	No
PP beetle	2	Equal	0.3323	No
PP beetle	3	Equal	0.4528	No
PP beetle	4	Equal	0.4111	No
PP beetle	5	Equal	0.7577	No

Table 152: Frequency and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
PP beetle	1	1.8	<1.0	1.6	<1.0
PP beetle	2	1.3	<1.0	1.4	<1.0
PP beetle	3	3.9	<1.0	5.1	<1.0
PP beetle	4	6.8	<1.0	5.7	<1.0
PP beetle	5	3.6	<1.0	3.3	<1.0

Table 153: Pair-wise Likelihood-Ratio Chi-squared test results for mountain pine beetle events in ponderosa pine by source and time period given an alternative assignment of species-type class.

Process event	*t*	Probability	Significant
PP beetle	1	0.387	No
PP beetle	2	0.508	No
PP beetle	3	0.001	Yes
PP beetle	4	0.002	Yes
PP beetle	5	0.207	No

Root disease events in ponderosa pine

Table 154: Acres and percent of total area for root disease events by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Root disease	1	31.2	<1.0	75.3	<1.0
Root disease	2	80.1	<1.0	137.2	<1.0
Root disease	3	267.6	<1.0	331.9	<1.0
Root disease	4	293.9	<1.0	363.7	<1.0
Root disease	5	316.7	<1.0	459.2	<1.0

Table 155: Pair-wise analysis of variance results root disease events by source and time period given an alternative assignment of species-type class.

Process Event	t	Test	Probability	Significant
Root disease	1	Unequal	0.0001	Yes
Root disease	2	Equal	0.0000	Yes
Root disease	3	Equal	0.0000	Yes
Root disease	4	Equal	0.0000	Yes
Root disease	5	Unequal	0.0008	Yes

Table 156: Frequency and percent of total area for root disease events by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Root disease	1	1.0	<1.0	3.5	<1.0
Root disease	2	2.2	<1.0	4.9	<1.0
Root disease	3	6.4	<1.0	9.5	<1.0
Root disease	4	7.3	<1.0	10.6	<1.0
Root disease	5	8.3	<1.0	13.2	<1.0

Table 157: Pair-wise Likelihood-Ratio Chi-squared test results for root disease events by source and time period given an alternative assignment of species-type class.

Process event	t	Probability	Significant
Root disease	1	0.001	Yes
Root disease	2	0.001	Yes
Root disease	3	0.001	Yes
Root disease	4	0.001	Yes
Root disease	5	0.001	Yes

Events spread from neighbors

Table 158: Acres and percent of total area for events spread from neighbor by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Spread from neighbor	1	5148.3	8.9	4603.6	7.9
Spread from neighbor	2	3068.0	5.3	3221.3	5.5
Spread from neighbor	3	3619.9	6.2	2901.2	5.0
Spread from neighbor	4	4561.5	7.9	3570.4	6.1
Spread from neighbor	5	4564.3	7.9	4274.4	7.4

Table 159: Pair-wise analysis of variance results for events spread from neighbor by source and time period given an alternative assignment of species-type class.

Process Event	t	Test	Probability	Significant
Spread from neighbor	1	Unequal	0.3579	No
Spread from neighbor	2	Unequal	0.9716	No
Spread from neighbor	3	Unequal	0.0106	Yes
Spread from neighbor	4	Unequal	0.0001	Yes
Spread from neighbor	5	Unequal	0.0046	Yes

Table 160: Frequency and percent of total area for events spread from neighbor by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Spread from neighbor	1	113.3	7.4	104.0	6.8
Spread from neighbor	2	80.6	5.2	84.6	5.5
Spread from neighbor	3	90.1	5.9	75.6	4.9
Spread from neighbor	4	111.2	7.2	93.8	6.1
Spread from neighbor	5	117.5	7.6	115.3	7.5

Table 161: Pair-wise Likelihood-Ratio Chi-squared test results for events spread from neighbor by source and time period given an alternative assignment of species-type class.

Process event	t	Probability	Significant
Spread from neighbor	1	0.001	Yes
Spread from neighbor	2	0.001	Yes
Spread from neighbor	3	0.001	Yes
Spread from neighbor	4	0.001	Yes
Spread from neighbor	5	0.132	No

Severe events

Table 162: Acres and percent of total area for severe events by source and time period given an alternative assignment of species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe events	1	2799.1	4.8	2562.7	4.4
Severe events	2	3616.3	6.2	3431.1	5.9
Severe events	3	3543.1	6.1	3222.1	5.5
Severe events	4	4346.4	7.5	3899.4	6.7
Severe events	5	4929.2	8.5	4897.4	8.4

Table 163: Pair-wise analysis of variance results for severe events by source and time period given an alternative assignment of species-type class.

Process Event	t	Test	Probability	Significant
Severe events	1	Equal	0.3838	No
Severe events	2	Unequal	0.0094	Yes
Severe events	3	Unequal	0.1803	No
Severe events	4	Unequal	0.0047	Yes
Severe events	5	Unequal	0.5922.	No

Table 164: Frequency and percent of total area for severe events by source and time period given an alternative assignment species-type class.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe events	1	71.3	4.6	64.5	4.2
Severe events	2	93.0	6.0	91.5	5.9
Severe events	3	97.5	6.3	90.4	5.9
Severe events	4	123.2	8.0	114.8	7.5
Severe events	5	147.5	9.6	145.6	9.5

Table 165: Pair-wise Likelihood-Ratio Chi-squared test results for severe events by source and time period given an alternative assignment of species-type class.

Process event	t	Probability	Significant
Severe events	1	0.001	No
Severe events	2	0.252	No
Severe events	3	0.001	Yes
Severe events	4	0.001	Yes
Severe events	5	0.243	No

Overall Event Summary for Species-type Classes

Table 166 provides a summary of event outcomes given an alternative assignment of species-type class from the re-classification of SILC. The 'Signif. Periods' column identifies the number of periods out of 5 where the statistical test was significant (null hypothesis rejected). The 'Trend' column indicates that the direction of change is increasing (+), decreasing (-) or modulating (±) across periods. An increase was interpreted as a net gain across periods, a decrease as a net loss across periods, and a modulation as compensating net gains and net losses across periods but with a redistribution as to when events occur among periods.

Table 166: Summary of event outcomes given an alternative assignment of species-type class.

Process event	Test Summary			
	Analysis of Variance on acres		Frequency of occurrence	
	Signif. Periods	Trend	Signif. Periods	Trend
Succession	0		4	+
Light-severity fire	0		3	-
Mixed-severity fire	3	-	5	-
Stand-replacing fire	1	-	3	-
Light budworm	3	-	5	-
Severe budworm	2	-	2	-
Light LPP beetle	0		4	+
Severe LPP beetle	0		5	+
PP beetle	0		2	±
Root disease	5	+	5	+
Spread from neighbor	3	-	4	-
Severe events	2	-	2	-

We conclude that the sample mean acres by period for all events except for succession, light-severity fire and all beetle events were significantly different between sources given an alternative assignment of species-type class. In all cases, except for root disease, there was a decrease in mean acres for each event. The frequencies of all events were significantly different between sources given an alternative assignment of species-type class. There was an increase in the frequency of succession, beetle events in lodgepole pine and root disease. There was a decrease in the frequency of all fires, budworm, and severe events. There was an increase in the frequency of all beetle events in

lodgepole pine and root disease. The numbers of beetle events in lodgepole pine doubled and root disease increased by 50 percent. The increase in beetle events was directly related to the increased proportion of lodgepole pine. The reduction in budworm was related to the reduced proportion of Douglas-fir. The increase in root disease was most likely related to a reduction in other events and not a significant consideration within this assessment area.

SCENARIO IV: Analysis of an Alternative Spatial Arrangement of Existing Types.

The objective of this scenario was to test differences in event outcomes given only a change in spatial arrangement with canopy closure, structure-size class, and species-type held constant. Our null hypothesis stated that there was no real difference in the sample mean acres or frequency distribution of events for a given spatial distribution. The source, as manifested by the distribution of polygons, was the independent variable. A rejection of the null hypothesis was interpreted as a change in spatial configuration (spatial arrangement) since the population attributes are directly comparable to the original TSMRS input. In this scenario we used the SILC derivation of polygons as an independent assessment of spatial arrangement. SILC polygons were assigned TSMRS attributes based on the coincident majority TSMRS type. Summary statistics and metrics for each data source are provided in Table 167. Table 168 provides the frequency distribution of acres for both data sources.

Table 167: Summary statistics and metrics for TSMRS and SILC polygon size.

	Source	
Metric/Statistic	Photo-interpreted	Satellite TM imagery
N (count)	1538 polygons	2941 polygons
Mean	37.8 acres	19.7 acres
Std. Dev.	116.0 acres	40.8 acres
Minimum	1 acre	1 acre
Maximum	6072 acres	1056 acres
Lower 95% CLM	29.5 acres	18.3 acres
Upper 95% CLM	46.1 acres	21.2 acres

Table 168: Frequency distribution of acres for TSMRS and SILC polygons.

Midpoint (acres)	Photo-interpreted	Satellite TM imagery
5	223	996
10	220	776
15	193	359
20	162	203
25	133	154
30	99	102
35	93	61
40	74	46
45	43	41
50	47	20
55	25	24
60	27	19
65	26	12
70	31	13
75	16	15
80	12	6
85	18	4
90	15	10
100	81	80

The question of polygon configuration was raised with all simulations. This question arose with the TSMRS base simulation within SIMPPLLE. As stands were assigned to SIMPPLLE states, distinguishing characteristics were lost, and sometimes two adjacent polygons had the same state label. One approach suggests dissolving the boundary between adjacent polygons with the same state label. This option lead to further data management or data processing, and a loss of the original polygon identifiers. The degree of aggregation was directly related to how polygon attributes were generalized to formulate state definitions within SIMPPLE. It was our experience that typically less than 1% of the polygons were aggregated due to similar adjacent states. In this test, SILC doubled the number of polygons over TSMRS and essentially represented the equivalent information. Therefore, the mapping of TSMRS attributes to SILC polygons represented an extreme case of this problem. If differences in this extreme situation were insignificant, we can assume that the aggregation of polygons with similar states would most often be unnecessary within the context of SIMPPLLE. If differences were significant, then we will identify those events that were most sensitive to changes in spatial configuration.

Analysis of Events by Source and Time Period given an Alternative Spatial Arrangement of Existing Types.

The following tables summarize the event spectrum for each decade (t) for 100 simulations of the Stevensville West Central assessment area. Each event is summarized in four tables. The first table summarizes acres by period for the event. The second table provides the analysis of variance T-test results. The third table summarizes the frequency by period for the event. The fourth provides the Likelihood-Ratio Chi-squared test results. These four tables appear on the following pages for each of the following events:

- Succession or stand development
- Light severity fire
- Mixed severity fire
- Stand-replacing fire
- Light western spruce budworm
- Severe western spruce budworm
- Light mountain pine beetle in lodgepole pine
- Severe mountain pine beetle in lodgepole pine
- Mountain pine beetle in ponderosa pine
- Root disease
- Events that spread from a neighboring stand polygons
- Aggregation of severe events (includes stand-replacing fire, severe western spruce budworm, and severe mountain pine beetle)

The presentation of event tables concludes with an overall discussion on trends and interpretations. Note that since we were comparing two distinct populations of polygons, the analysis of variance T-test would likely always reject the null hypothesis for all periods and the difference in population means would be significantly different.

Succession events

Table 169: Acres and percent of total area for succession events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Succession	1	47981.5	82.6	44977.1	77.5
Succession	2	47580.1	81.9	46295.0	79.8
Succession	3	46195.3	79.5	43638.5	75.2
Succession	4	43130.9	74.2	41565.0	71.7
Succession	5	41077.6	70.7	38923.6	67.1

Table 170: Pair-wise analysis of variance results for succession events by source and time period given an alternative spatial arrangement of existing types.

Process Event	*T*	Test	Probability	Significant
Succession	1	Unequal	0.0001	Yes
Succession	2	Unequal	0.0001	Yes
Succession	3	Unequal	0.0001	Yes
Succession	4	Unequal	0.0001	Yes
Succession	5	Unequal	0.0001	Yes

Table 171: Frequency and percent of total area for succession events by source and time period given an alternative spatial arrangement of existing types.

Process event	*T*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Succession	1	1294.5	84.1	2474.6	84.1
Succession	2	1260.4	81.9	2482.3	84.4
Succession	3	1222.7	79.5	2379.1	80.9
Succession	4	1126.6	73.3	2266.8	77.1
Succession	5	1056.6	68.7	2112.0	71.8

Table 172: Pair-wise Likelihood-Ratio Chi-squared test results for succession events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
Succession	1	0.813	No
Succession	2	0.001	Yes
Succession	3	0.001	Yes
Succession	4	0.001	Yes
Succession	5	0.001	Yes

Light-severity fire events

Table 173: Acres and percent of total area for light-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light-severity fire	1	284.2	<1.0	336.5	<1.0
Light-severity fire	2	233.6	<1.0	251.1	<1.0
Light-severity fire	3	247.1	<1.0	273.1	<1.0
Light-severity fire	4	331.4	<1.0	304.2	<1.0
Light-severity fire	5	335.5	<1.0	303.1	<1.0

Table 174: Pair-wise analysis of variance results for light-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process Event	*t*	Test	Probability	Significant
Light-severity fire	1	Unequal	0.0001	Yes
Light-severity fire	2	Unequal	0.0001	Yes
Light-severity fire	3	Equal	0.0000	Yes
Light-severity fire	4	Unequal	0.0001	Yes
Light-severity fire	5	Unequal	0.0001	Yes

Table 175: Frequency and percent of total area for light-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light-severity fire	1	8.1	<1.0	14.3	<1.0
Light-severity fire	2	7.3	<1.0	12.4	<1.0
Light-severity fire	3	7.2	<1.0	13.3	<1.0
Light-severity fire	4	8.4	<1.0	14.5	<1.0
Light-severity fire	5	9.2	<1.0	16.8	<1.0

Table 176: Pair-wise Likelihood-Ratio Chi-squared test results for light-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
Light-severity fire	1	0.043	Yes
Light-severity fire	2	0.017	Yes
Light-severity fire	3	0.481	No
Light-severity fire	4	0.018	Yes
Light-severity fire	5	0.290	No

Mixed-severity fire events

Table 177: Acres and percent of total area for mixed-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Mixed-severity fire	1	1800.1	3.1	2395.4	4.1
Mixed-severity fire	2	1368.5	2.4	1939.0	3.3
Mixed-severity fire	3	2201.6	3.8	3530.3	6.1
Mixed-severity fire	4	2613.8	4.5	3309.7	5.7
Mixed-severity fire	5	2361.5	4.1	3379.2	5.8

Table 178: Pair-wise analysis of variance results for mixed-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process Event	*t*	Test	Probability	Significant
Mixed-severity fire	1	Unequal	0.0001	Yes
Mixed-severity fire	2	Unequal	0.1383	No
Mixed-severity fire	3	Unequal	0.1226	No
Mixed-severity fire	4	Unequal	0.0709	No
Mixed-severity fire	5	Unequal	0.6810	No

Table 179: Frequency and percent of total area for mixed-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Mixed-severity fire	1	36.7	2.4	78.4	2.7
Mixed-severity fire	2	31.4	2.0	47.3	1.6
Mixed-severity fire	3	52.0	3.4	88.0	3.0
Mixed-severity fire	4	58.7	3.8	79.9	2.7
Mixed-severity fire	5	54.8	3.6	79.7	2.7

Table 180: Pair-wise Likelihood-Ratio Chi-squared test results for mixed-severity fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
Mixed-severity fire	1	0.001	Yes
Mixed-severity fire	2	0.001	Yes
Mixed-severity fire	3	0.001	Yes
Mixed-severity fire	4	0.001	Yes
Mixed-severity fire	5	0.001	Yes

Stand-replacing fire events

Table 181: Acres and percent of total area for stand-replacing fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Stand-replacing fire	1	1937.2	3.3	3261.4	5.6
Stand-replacing fire	2	1215.3	2.1	1291.6	2.2
Stand-replacing fire	3	1398.5	2.4	1709.2	2.9
Stand-replacing fire	4	1512.3	2.6	1165.7	2.0
Stand-replacing fire	5	1052.5	1.8	945.3	1.6

Table 182: Pair-wise analysis of variance results for stand-replacing fire events by source and time period given an alternative spatial arrangement of existing types.

Process Event	*t*	Test	Probability	Significant
Stand-replacing fire	1	Unequal	0.0001	Yes
Stand-replacing fire	2	Unequal	0.0001	Yes
Stand-replacing fire	3	Unequal	0.0001	Yes
Stand-replacing fire	4	Unequal	0.0001	Yes
Stand-replacing fire	5	Equal	0.0000	Yes

Table 183: Frequency and percent of total area for stand-replacing fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Stand-replacing fire	1	52.7	3.4	103.1	3.5
Stand-replacing fire	2	32.6	2.1	44.3	1.5
Stand-replacing fire	3	37.7	2.5	63.4	2.2
Stand-replacing fire	4	39.9	2.6	47.9	1.6
Stand-replacing fire	5	29.9	1.9	39.6	1.3

Table 184: Pair-wise Likelihood-Ratio Chi-squared test results for stand-replacing fire events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
Stand-replacing fire	1	0.153	No
Stand-replacing fire	2	0.001	Yes
Stand-replacing fire	3	0.001	Yes
Stand-replacing fire	4	0.001	Yes
Stand-replacing fire	5	0.001	Yes

Light western spruce budworm events

Table 185: Acres and percent of total area for light western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total Acres	% of area	Total acres	% of area
Light budworm	1	5137.7	8.8	5698.6	9.8
Light budworm	2	5155.7	8.9	4933.9	8.5
Light budworm	3	5467.3	9.4	5748.6	9.9
Light budworm	4	7091.4	12.2	7405.1	12.8
Light budworm	5	8912.0	15.3	9381.7	16.2

Table 186: Pair-wise analysis of variance results light western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Light budworm	1	Unequal	0.0001	Yes
Light budworm	2	Unequal	0.0001	Yes
Light budworm	3	Unequal	0.0001	Yes
Light budworm	4	Unequal	0.0001	Yes
Light budworm	5	Unequal	0.0001	Yes

Table 187: Frequency and percent of total area for light western spruce budworm by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light budworm	1	123.8	8.1	229.4	7.8
Light budworm	2	142.1	9.2	214.9	7.3
Light budworm	3	147.5	9.6	268.7	9.1
Light budworm	4	204.6	13.3	344.0	11.7
Light budworm	5	256.5	16.7	463.1	15.7

Table 188: Pair-wise Likelihood-Ratio Chi-squared test results for light western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Light budworm	1	0.004	Yes
Light budworm	2	0.001	Yes
Light budworm	3	0.001	Yes
Light budworm	4	0.001	Yes
Light budworm	5	0.001	Yes

Severe western spruce budworm events

Table 189: Acres and percent of total area for severe western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe budworm	1	852.1	1.5	1261.9	2.2
Severe budworm	2	2395.6	4.1	3155.4	5.4
Severe budworm	3	2135.6	3.7	2499.8	4.3
Severe budworm	4	2794.9	4.8	3529.2	6.1
Severe budworm	5	3854.6	6.6	4394.2	7.6

Table 190: Pair-wise analysis of variance results for severe western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Severe budworm	1	Unequal	0.0001	Yes
Severe budworm	2	Unequal	0.0001	Yes
Severe budworm	3	Unequal	0.0001	Yes
Severe budworm	4	Unequal	0.0001	Yes
Severe budworm	5	Unequal	0.0001	Yes

Table 191: Frequency and percent of total area for severe western spruce budworm by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe budworm	1	18.4	1.2	36.4	1.2
Severe budworm	2	60.3	3.9	132.7	4.5
Severe budworm	3	59.5	3.9	106.8	3.6
Severe budworm	4	82.0	5.3	158.1	5.4
Severe budworm	5	116.7	7.6	205.1	7.0

Table 192: Pair-wise Likelihood-Ratio Chi-squared test results for severe western spruce budworm events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Severe budworm	1	0.239	No
Severe budworm	2	0.001	Yes
Severe budworm	3	0.001	Yes
Severe budworm	4	0.527	No
Severe budworm	5	0.001	Yes

Light mountain pine beetle events in lodgepole pine

Table 193: Acres and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Light LPP beetle	1	30.0	<1.0	24.8	<1.0
Light LPP beetle	2	11.6	<1.0	9.2	<1.0
Light LPP beetle	3	34.0	<1.0	16.8	<1.0
Light LPP beetle	4	70.0	<1.0	46.1	<1.0
Light LPP beetle	5	42.9	<1.0	25.6	<1.0

Table 194: Pair-wise analysis of variance results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Light LPP beetle	1	Unequal	0.0001	Yes
Light LPP beetle	2	Unequal	0.0001	Yes
Light LPP beetle	3	Unequal	0.0005	Yes
Light LPP beetle	4	Unequal	0.5972	No
Light LPP beetle	5	Equal	0.4882	No

Table 195: Frequency and percent of total area for light mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Light LPP beetle	1	0.7	<1.0	1.0	<1.0
Light LPP beetle	2	0.3	<1.0	0.6	<1.0
Light LPP beetle	3	0.8	<1.0	0.6	<1.0
Light LPP beetle	4	2.4	<1.0	1.7	<1.0
Light LPP beetle	5	1.5	<1.0	1.0	<1.0

Table 196: Pair-wise Likelihood-Ratio Chi-squared test results for light mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Light LPP beetle	1	0.047	Yes
Light LPP beetle	2	0.922	No
Light LPP beetle	3	0.001	Yes
Light LPP beetle	4	0.001	Yes
Light LPP beetle	5	0.001	Yes

Severe mountain pine beetle events in lodgepole pine

Table 197: Acres and percent of total area for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe LPP beetle	1	9.8	<1.0	7.4	<1.0
Severe LPP beetle	2	5.4	<1.0	3.8	<1.0
Severe LPP beetle	3	9.0	<1.0	7.9	<1.0
Severe LPP beetle	4	39.2	<1.0	21.4	<1.0
Severe LPP beetle	5	22.0	<1.0	19.4	<1.0

Table 198: Pair-wise analysis of variance results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Severe LPP beetle	1	Unequal	0.0001	Yes
Severe LPP beetle	2	Unequal	0.0001	Yes
Severe LPP beetle	3	Equal	0.0081	Yes
Severe LPP beetle	4	Unequal	0.2524	No
Severe LPP beetle	5	Equal	0.3693	No

Table 199: Frequency and percent of total area of severe mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe LPP beetle	1	0.3	<1.0	0.7	<1.0
Severe LPP beetle	2	0.1	<1.0	0.3	<1.0
Severe LPP beetle	3	0.3	<1.0	0.4	<1.0
Severe LPP beetle	4	1.3	<1.0	0.9	<1.0
Severe LPP beetle	5	0.9	<1.0	0.9	<1.0

Table 200: Pair-wise Likelihood-Ratio Chi-squared test results for severe mountain pine beetle events in lodgepole pine by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Severe LPP beetle	1	0.207	No
Severe LPP beetle	2	0.388	No
Severe LPP beetle	3	0.371	No
Severe LPP beetle	4	0.001	Yes
Severe LPP beetle	5	0.001	Yes

Mountain pine beetle events in ponderosa pine

Table 201: Acres and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
PP beetle	1	36.2	<1.0	17.3	<1.0
PP beetle	2	54.1	<1.0	49.4	<1.0
PP beetle	3	144.0	<1.0	147.4	<1.0
PP beetle	4	222.2	<1.0	236.7	<1.0
PP beetle	5	124.7	<1.0	137.7	<1.0

Table 202: Pair-wise analysis of variance results for mountain pine beetle events in ponderosa pine by source and time period given an alternative spatial arrangement of existing types.

Process Event	*t*	Test	Probability	Significant
PP beetle	1	Equal	0.0000	Yes
PP beetle	2	Unequal	0.0001	Yes
PP beetle	3	Equal	0.0000	Yes
PP beetle	4	Unequal	0.0001	Yes
PP beetle	5	Unequal	0.0009	Yes

Table 203: Frequency and percent of total area for mountain pine beetle events in ponderosa pine by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
PP beetle	1	1.8	<1.0	1.6	<1.0
PP beetle	2	1.3	<1.0	2.5	<1.0
PP beetle	3	3.9	<1.0	6.8	<1.0
PP beetle	4	6.8	<1.0	11.7	<1.0
PP beetle	5	3.6	<1.0	6.2	<1.0

Table 204: Pair-wise Likelihood-Ratio Chi-squared test results for mountain pine beetle events in ponderosa pine by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
PP beetle	1	0.001	Yes
PP beetle	2	0.815	No
PP beetle	3	0.116	No
PP beetle	4	0.028	Yes
PP beetle	5	0.099	No

Root disease events in ponderosa pine

Table 205: Acres and percent of total area for root disease events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Root disease	1	31.2	<1.0	29.6	<1.0
Root disease	2	80.1	<1.0	81.6	<1.0
Root disease	3	267.6	<1.0	438.4	<1.0
Root disease	4	293.9	<1.0	426.9	<1.0
Root disease	5	316.7	<1.0	500.3	<1.0

Table 206: Pair-wise analysis of variance results root disease events by source and time period given an alternative spatial arrangement of existing types.

Process Event	*t*	Test	Probability	Significant
Root disease	1	Unequal	0.0000	Yes
Root disease	2	Unequal	0.0001	Yes
Root disease	3	Unequal	0.0001	Yes
Root disease	4	Unequal	0.0001	Yes
Root disease	5	Unequal	0.0001	Yes

Table 207: Frequency and percent of total area for root disease events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Root disease	1	1.0	<1.0	1.5	<1.0
Root disease	2	2.2	<1.0	3.7	<1.0
Root disease	3	6.4	<1.0	13.9	<1.0
Root disease	4	7.3	<1.0	15.5	<1.0
Root disease	5	8.3	<1.0	16.6	<1.0

Table 208: Pair-wise Likelihood-Ratio Chi-squared test results for root disease events by source and time period given an alternative spatial arrangement of existing types.

Process event	*t*	Probability	Significant
Root disease	1	0.034	Yes
Root disease	2	0.199	No
Root disease	3	0.010	Yes
Root disease	4	0.013	Yes
Root disease	5	0.288	No

Events spread from neighbors

Table 209: Acres and percent of total area for events spread from neighbor by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Spread from neighbor	1	5148.3	8.9	7544.9	13.0
Spread from neighbor	2	3068.0	5.3	7544.9	13.0
Spread from neighbor	3	3619.9	6.2	5368.6	9.3
Spread from neighbor	4	4561.5	7.9	5368.6	9.3
Spread from neighbor	5	4564.3	7.9	5682.3	9.8

Table 210: Pair-wise analysis of variance results for events spread from neighbor by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Spread from neighbor	1	Unequal	0.0001	Yes
Spread from neighbor	2	Unequal	0.0001	Yes
Spread from neighbor	3	Unequal	0.0001	Yes
Spread from neighbor	4	Unequal	0.0001	Yes
Spread from neighbor	5	Unequal	0.0001	Yes

Table 211: Frequency and percent of total area for events spread from neighbor by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Spread from neighbor	1	113.3	7.4	247.5	8.4
Spread from neighbor	2	80.6	5.2	247.5	8.4
Spread from neighbor	3	90.1	5.9	152.7	5.2
Spread from neighbor	4	111.2	7.2	152.7	5.2
Spread from neighbor	5	117.5	7.6	181.7	6.2

Table 212: Pair-wise Likelihood-Ratio Chi-squared test results for events spread from neighbor by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Spread from neighbor	1	0.001	Yes
Spread from neighbor	2	0.001	Yes
Spread from neighbor	3	0.001	Yes
Spread from neighbor	4	0.001	Yes
Spread from neighbor	5	0.001	Yes

Severe events

Table 213: Acres and percent of total area for severe events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		Total acres	% of area	Total acres	% of area
Severe events	1	2799.1	4.8	4530.8	7.8
Severe events	2	3616.3	6.2	4450.8	7.7
Severe events	3	3543.1	6.1	4216.9	7.3
Severe events	4	4346.1	7.5	4716.3	8.1
Severe events	5	4929.2	8.5	5358.9	9.2

Table 214: Pair-wise analysis of variance results for severe events by source and time period given an alternative spatial arrangement of existing types.

Process Event	t	Test	Probability	Significant
Severe events	1	Unequal	0.0001	Yes
Severe events	2	Unequal	0.0001	Yes
Severe events	3	Unequal	0.0001	Yes
Severe events	4	Unequal	0.0001	Yes
Severe events	5	Unequal	0.0001	Yes

Table 215: Frequency and percent of total area for severe events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Source			
		Photo-interpreted		Satellite TM imagery	
		N	% of stands	N	% of stands
Severe events	1	71.3	4.6	140.2	4.8
Severe events	2	93.0	6.0	177.3	6.0
Severe events	3	97.5	6.3	170.6	5.8
Severe events	4	123.2	8.0	206.9	7.0
Severe events	5	147.5	9.6	245.6	8.4

Table 216: Pair-wise Likelihood-Ratio Chi-squared test results for severe events by source and time period given an alternative spatial arrangement of existing types.

Process event	t	Probability	Significant
Severe events	1	0.054	No
Severe events	2	0.784	No
Severe events	3	0.001	Yes
Severe events	4	0.001	Yes
Severe events	5	0.001	Yes

Overall Event Summary for a Change in Spatial Arrangement

Table 217 provides a summary of event outcomes given an alternative assignment of species-type class from the re-classification of SILC. The 'Signif. Periods' column identifies the number of periods out of 5 where the statistical test was significant (null hypothesis rejected). The 'Trend' column indicates that the direction of change is increasing (+), decreasing (-) or modulating (±) across periods. An increase was interpreted as a net gain across periods, a decrease as a net loss across periods, and a modulation as compensating net gains and net losses across periods but with a redistribution as to when events occur among periods.

Table 217: Summary of event outcomes given an alternative spatial arrangement

Process event	Test Summary			
	Analysis of Variance on acres		Frequency of occurrence	
	Signif. Periods	Trend	Signif. Periods	Trend
Succession	5	-	4	+
Light-severity fire	5	±	3	+
Mixed-severity fire	1	+	5	+
Stand-replacing fire	5	±	4	+
Light budworm	5	+	5	+
Severe budworm	5	+	3	+
Light LPP beetle	3	-	4	±
Severe LPP beetle	3	-	2	±
PP beetle	5	+	2	+
Root disease	5	+	3	+
Spread from neighbor	5	+	5	+
Severe events	5	+	3	+

The frequencies of all events were significantly different between sources given an alternative spatial arrangement. There was an increase in the frequency of all events except for beetle events in lodgepole pine. There was a 50 to 100% increase in the frequency of succession, all fire events, severe budworm, and root disease. The increase in fire and budworm may relate directly to an increase in the number of adjacent polygons as indicated by the number of spread events. The increase in succession was due to that fact that a large number of events occurred in the first period, allowing for succession to proceed in subsequent periods. A change in spatial arrangement caused an obvious change in the

event spectrum, but difficult to interpret without evaluating the process rules for each event. It is important to remember that this was an extreme implementation of a change in spatial arrangement, but not an impossible case. If SIMPPLLE states were defined specifically for the SILC classification then it is quite possible to see similar results just due to a two-fold increase in the number of polygons. It would depend greatly on how processes where implemented for SILC-specific state definitions. It was our experience that under normal situations dissolving the polygon boundaries of adjacent polygons with similar states has very little if any impact on the event spectrum.

Overall Event Summary

Table 218 and Table 219 provide a composite view of the summary of event outcomes from all four scenarios. Table 218 provides an overall summary of the analysis of variance T-test. In terms of the number of significant periods (SP), the means for process events mostly differ from TSMRS for spatial arrangement and followed in decreasing importance by structure-size, species-type and canopy closure class. The trend (T) columns in Table 218 generally indicate a overall decline in means for all scenarios except for a change in spatial arrangement, which exhibited an overall increase.

Table 218: Summary of event outcomes for analysis of variance test for all scenarios (SP = number of significant periods, T = trend)

Process event	Canopy		Struct-Size		Species		Spatial Arrang.	
	SP	T	SP	T	SP	T	SP	T
Succession	0		0		0		5	-
Light-severity fire	0		0		0		5	±
Mixed-severity fire	0		5	-	3	-	1	+
Stand-replacing fire	3	-	3	±	1	-	5	±
Light budworm	0		5	-	3	-	5	+
Severe budworm	0		3	-	2	-	5	+
Light LPP beetle	1	-	0		0		3	-
Severe LPP beetle	0		1	±	0		3	-
PP beetle	0		2	±	0		5	+
Root disease	0		4	-	5	+	5	+
Spread from neighbor	0		5	-	3	-	5	+
Severe events	1	±	3	-	2	-	5	+

Table 219 provides an overall summary of the frequency of occurrence test. Frequency was significantly different for all scenarios across most periods, but particularly significant for a change in structure-size class. The trend (T) columns in Table 219 generally indicate an overall decline in the frequency of events for all scenarios except for a change in spatial arrangement, which exhibited an overall increase. The trend for changes in canopy closure tended to be the inverse of trends for changes in species-type.

Table 219: Summary of event outcomes for frequency of occurrence test for all scenarios (SP = number of significant periods, T = trend)

Process event	Canopy		Struct-Size		Species		Spatial Arrang.	
	SP	T	SP	T	SP	T	SP	T
Succession	4	-	5	+	4	+	4	+
Light-severity fire	3	+	5	-	3	-	3	+
Mixed-severity fire	2	±	5	-	5	-	5	+
Stand-replacing fire	5	-	5	±	3	-	4	+
Light budworm	5	+	5	-	5	-	5	+
Severe budworm	5	+	5	-	2	-	3	+
Light LPP beetle	2	-	5	±	4	+	4	±
Severe LPP beetle	2	-	5	±	5	+	2	±
PP beetle	3	±	5	±	2	±	2	+
Root disease	0		5	+	5	+	3	+
Spread from neighbor	3	±	5	-	4	-	5	+
Severe events	5	±	4	-	2	-	3	+

From these summaries and specific observations, there are a few issues that should be considered in the application of SIMPPLLE:

- The synchronization of structural and thematic classifications was important to model performance. Landscape behavior is defined by the interaction of processes with state variables and their associated geographic representation. Process behavior is described and implemented within the context of a given structural and thematic representation. Changing the structural representation may also change how processes are described in the model. This lack of synchronization was evident in the fact that the landscape became more diverse in subsequent time periods even though the simulation began with a generalized description.

- The results represented in the summary tables were probably less extreme than if a SILC-specific implementation were possible. In this analysis every effort was made to push the mapping of SILC attributes to SIMPPLLE states closer to TSMRS.
- Testing for a difference in means was probably not meaningful. For most applications an unbiased method for structural delineation would be a prerequisite to testing for a difference in means. In this case SILC probably offered a less biased structural delineation than TSMRS because the SILC delineation was a systematic rule-based approach, but there was no independent means to test this assumption.
- A derivation or mapping of potential vegetation independent of existing vegetation and at the appropriate resolution would be helpful for model testing.

Observations and Recommendations

The original goal of Objective I was to assess whether an alternative classification of vegetation at a coarser scale resulted in a real perceived difference in the frequency and distribution of process events at the next finest scale and how management decisions might be altered given those perceptions. Differences in event spectrums due to changes in canopy closure, structure-size class, species-type and spatial arrangements were documented in this report. It is much more difficult to assess the management implications. Some insight into what it may mean to the assessment process was gained by reviewing a document prepared for the Bitterroot National Forest by Dr.Chew, developer of SIMPPLLE, on the comparison of management alternatives using SIMPPLLE. In the absence of a formal evaluation and quantification process similar to the methods outlined in this report, based on Dr. Chew's report it is apparent that classification differences would overshadow any differences in management alternatives. That is, it was highly likely that differences in classification result in more change in the event spectrum than any management alternative developed through the planning process would produce. This observation alone re-emphasizes a number of issues that must be considered:

- The results represented in the summary tables were probably less extreme than if a SILC-specific implementation were possible. In this analysis every effort was made to push the mapping of SILC attributes to SIMPPLLE states closer to TSMRS.
- Testing for a difference in means was probably not meaningful. For most applications an unbiased method for structural delineation would be a prerequisite to testing for a difference in means. In this case SILC probably offered a less biased structural delineation than TSMRS because the SILC delineation was a systematic rule-based approach, but there was no independent means to test this assumption.
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- Research needs to invest time in evaluating landscape metrics and statistics applicable to the interaction of landscape composition and configuration.

Overall, from an ecological viewpoint, we were pleased with the performance of SIMPPLLE. To the degree we could assess model performance, the model seemed to respond in an ecologically correct manner with changes in input. Our one recommendation in this regard would be to further investigate and evaluate the results of severe changes in spatial arrangement. This could be an important factor to consider when applying SIMPPLLE to both structural and thematic classification hierarchies.

Objective 3 - Change in Extent

Our second key objective was to evaluate changes in the event spectrum produced for the fine-scale assessment area due to a change in extent. This analysis embed the TSMRS data for the Stevensville West Central assessment area analyzed in Objective I within a much broader but ecologically similar landscape. Given the similarity of the adjacent landscape for this area, we would have expected very little change in the event spectrum.

Unfortunately, this analysis could not proceed within the time frame allocated for this project. Due to personnel availability and budget constraints, the Bitterroot National Forest found it difficult to provide the data necessary to conduct this analysis in the time frame allotted.

Literature Cited

Chew, J.D. 1995. Development of a system for simulating vegetative states and processes at landscape scales. Ph. D. Thesis. University of Montana. 182 p.

Redmond, R.L., et. al. 1996. Mapping Existing Vegetation And Land Cover Across Western Montana And Northern Idaho Final Report Contract No. 53-0343-4000012, Submitted To: U.S. Department Of Agriculture Forest Service, Northern Regional Office Missoula, Mt. 971 p.

Appendix A: SILC Cover-type to SIMPPLLE State Reassignments

Table 220: Portion of a correspondence table of the distribution of SILC types across SIMPPLLE species groups by percent of total area within a SILC cover-type for potential vegetation Group A. Columns sum to 100%.

SIMPPLLE species group	SILC Type 4102	SILC Type 4201	SILC Type 4203	SILC Type 4206	SILC Type 4207	SILC Type 4208	SILC Type 4210	SILC Type 4212
AF	0	0	0	0	0	0	0	0
AL	0	0	0	0	0	0	0	0
CW	0	0	0	0	0	0	0	0
CW-MC	0	0	0	0	0	0	0	0
DF	0	0	0	0	0	0	0	0
DF-GF	0	0	0	0	0	0	0	0
DF-LP	0	0	0	0	0	0	0	0
DF-LP-AF	0	0	0	0	0	0	0	0
DF-PP-GF	0	0	0	0	0	0	0	0
ES-AF	0	0	0	0	0	0	0	0
GF	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0
L-DF	0	0	0	0	0	0	0	0
L-DF-AF	0	0	0	0	0	0	0	0
L-DF-GF	0	0	0	0	0	0	0	0
L-DF-PP	0	0	0	0	0	0	0	0
L-DF-PP-LP	0	0	0	0	0	0	0	0
L-LP	0	0	0	0	0	0	0	0
L-LP-DF-AF	0	0	0	0	0	0	0	0
L-LP-DF-GF	0	0	0	0	0	0	0	0
L-PP	0	0	0	0	0	0	0	0
L-PP-LP	0	0	0	0	0	0	0	0
LP	0	0	0	0	0	0	0	0
NF	0	0	0	0	0	0	0	0
NS	11	0	8	22	20	100	0	7
PP	82	0	67	68	80	0	0	67
PP-DF	7	0	25	10	0	0	0	27
QA	0	0	0	0	0	0	0	0
QA-MC	0	0	0	0	0	0	0	0
WB	0	0	0	0	0	0	0	0

Table 221: Reassignment table for SILC cover-type to SIMPPLLE state.

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-A	2000	AGR	PP-DF	NS
WMT-A	3101	NS	NS	PP
WMT-A	3102	NS	PP	PP-DF
WMT-A	3104	NS	NS	PP

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-A	3202	NS	PP-DF	PP
WMT-A	3306	NS	PP-DF	
WMT-A	4102	*	PP	NS
WMT-A	4203	*	PP	PP-DF
WMT-A	4206	PP	PP	PP-DF
WMT-A	4207	*	PP	NS
WMT-A	4208	*	NS	
WMT-A	4212	DF	PP	PP-DF
WMT-A	4220	*	PP	NS
WMT-A	4221	*	PP	
WMT-A	4222	PP-DF	PP	PP-DF
WMT-A	4223	DF	PP-DF	
WMT-A	4225	DF	PP	NS
WMT-A	4226	*	PP	
WMT-A	4229	*	PP	
WMT-A	7300	NF	NS	PP
WMT-A	7800	NF	PP	NS
WMT-B	2000	AGR	NS	PP-DF
WMT-B	3101	NS	NS	PP-DF
WMT-B	3102	NS	NS	PP-DF
WMT-B	3104	NS	PP-DF	DF
WMT-B	3202	NS	PP-DF	NS
WMT-B	3203	NS	DF	PP-DF
WMT-B	3306	NS	PP-DF	NS
WMT-B	4102	CW	NS	PP-DF
WMT-B	4201	*	PP-DF	
WMT-B	4203	*	DF	L-DF-PP
WMT-B	4206	PP	PP-DF	DF
WMT-B	4207	*	PP-DF	L-DF-PP
WMT-B	4208	*	PP-DF	L-DF
WMT-B	4210	*	DF	NS
WMT-B	4212	DF	PP-DF	DF
WMT-B	4215	L-DF-PP	PP-DF	DF
WMT-B	4219	*	DF	L-DF
WMT-B	4220	*	DF	L-DF-PP
WMT-B	4221	*	PP-DF	L-DF
WMT-B	4222	PP-DF	PP-DF	DF
WMT-B	4223	DF	PP-DF	DF
WMT-B	4225	DF	PP-DF	L-DF
WMT-B	4226	*	PP-DF	DF
WMT-B	4228	*	PP-DF	L-DF
WMT-B	4229	L-DF	DF	
WMT-B	4301	CW-MC	PP-DF	L-DF-PP
WMT-B	5000	NF	PP-DF	DF
WMT-B	7300	NF	PP-DF	NS
WMT-B	7800	NF	NS	PP-DF
WMT-C	3101	NS	DF	
WMT-C	3102	NS	DF	
WMT-C	3104	NS	DF	QA-MC

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-C	3202	NS	DF	L-PP
WMT-C	3203	NS	DF	NS
WMT-C	4201	*	DF	
WMT-C	4203	*	DF	L-DF-PP-LP
WMT-C	4206	*	DF	L-DF-PP-LP
WMT-C	4207	*	DF	L-PP
WMT-C	4208	*	DF	L-DF
WMT-C	4212	DF	DF	L-DF
WMT-C	4215	L-DF-PP	DF	L-DF-PP
WMT-C	4220	*	DF	L-PP-LP
WMT-C	4221	*	DF	L-PP
WMT-C	4222	*	DF	
WMT-C	4223	DF	DF	L-PP
WMT-C	4225	DF	DF	
WMT-C	4228	L-DF-PP-LP	DF	
WMT-C	4301	QA-MC	DF	L-DF-PP-LP
WMT-C	5000	NF	DF	
WMT-C	7300	NF	DF	
WMT-C	7800	NF	DF	L-DF-PP
WMT-D	3101	NS	L	
WMT-D	3104	NS	L-LP	
WMT-D	3202	NS	L-LP-DF-GF	L
WMT-D	3203	NS	L-LP	L-DF-GF
WMT-D	4203	L-LP	L-DF-GF	L-LP
WMT-D	4206	*	L	
WMT-D	4207	*	L	L-DF-GF
WMT-D	4208	*	L-LP	L-DF-GF
WMT-D	4210	*	L	
WMT-D	4212	DF-GF	L-LP	L-DF-GF
WMT-D	4219	*	L-LP	
WMT-D	4220	*	L-LP	L-DF-GF
WMT-D	4221	*	L-DF-GF	L-LP
WMT-D	4222	*	L-LP-DF-GF	L-DF-GF
WMT-D	4225	DF-GF	L-LP	
WMT-D	4226	*	L-DF-GF	L
WMT-E	3101	NS	L-DF-AF	
WMT-E	3104	NS	L-DF-AF	DF
WMT-E	3202	NS	L-DF-AF	
WMT-E	3203	NS	L-DF-AF	DF
WMT-E	4102	QA	L-DF-AF	
WMT-E	4201	*	L-DF-AF	DF
WMT-E	4203	LP	L-DF-AF	DF
WMT-E	4206	*	L-DF-AF	NS
WMT-E	4207	*	DF	L-LP-DF-AF
WMT-E	4208	AF	L-DF-AF	NS
WMT-E	4210	*	L-DF-AF	
WMT-E	4212	DF	L-DF-AF	DF
WMT-E	4215	L-DF-AF	L-DF-AF	
WMT-E	4219	*	L-DF-AF	DF-LP

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-E	4220	DF-LP-AF	L-DF-AF	DF
WMT-E	4221	*	L-DF-AF	DF
WMT-E	4222	*	L-DF-AF	DF
WMT-E	4223	DF-LP	L-DF-AF	DF
WMT-E	4225	DF	L-DF-AF	DF
WMT-E	4228	L-LP-DF-AF	L-DF-AF	DF
WMT-E	4229	L-DF-AF	L-DF-AF	
WMT-E	5000	NF	L-DF-AF	DF
WMT-E	7300	NF	L-DF-AF	DF
WMT-E	7800	NF	NS	DF
WMT-E	9100	NF	L-DF-AF	
WMT-F	4208	AF	AF	
WMT-F	4220	AF	AF	
WMT-G	2000	AGR	NS	CW
WMT-G	3101	NS	NS	CW
WMT-G	3102	NS	NS	CW-MC
WMT-G	3104	NS	L-DF-GF	
WMT-G	3202	NS	L-DF-GF	NS
WMT-G	3203	NS	L-DF-GF	L-DF
WMT-G	3306	NS	CW-MC	DF-PP-GF
WMT-G	4102	QA	DF-PP-GF	CW
WMT-G	4201	*	L-DF	
WMT-G	4203	*	L-DF-GF	L-DF
WMT-G	4206	PP-DF	CW-MC	L-DF
WMT-G	4207	GF	L-DF	DF-PP-GF
WMT-G	4208	*	L-DF-GF	
WMT-G	4210	*	L-DF-GF	GF
WMT-G	4212	L-DF	L-DF-GF	DF-PP-GF
WMT-G	4215	L-DF	L-DF-GF	DF-PP-GF
WMT-G	4220	*	L-DF	L-DF-GF
WMT-G	4221	*	L-DF-GF	DF-PP-GF
WMT-G	4222	PP-DF	DF-PP-GF	L-LP-DF-GF
WMT-G	4223	*	L-DF-GF	CW-MC
WMT-G	4225	DF-GF	CW-MC	L-DF-GF
WMT-G	4226	*	CW-MC	
WMT-G	4228	L-LP-DF-GF	L-DF	L-DF-GF
WMT-G	4229	L-DF	L-DF	
WMT-G	4301	QA-MC	L-DF-GF	
WMT-G	5000	NF	NS	DF-PP-GF
WMT-G	7300	NF	NS	DF-PP-GF
WMT-G	7800	NF	NS	DF-PP-GF
WMT-H	3101	NS	L-DF-AF	
WMT-H	3102	NS	L-DF-AF	
WMT-H	3104	NS	AF	L-DF-AF
WMT-H	3202	NS	L-DF	L-LP-DF-AF
WMT-H	3203	NS	AF	L-DF-AF
WMT-H	4201	*	L-DF	L-DF-AF
WMT-H	4203	LP	LP	L-DF-AF
WMT-H	4206	*	L-DF-AF	AF

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-H	4207	*	LP	L-DF-AF
WMT-H	4208	AF	LP	L-DF-AF
WMT-H	4212	L-DF	L-DF-AF	AF
WMT-H	4215	L-DF	AF	L-DF-AF
WMT-H	4219	*	L-DF-AF	LP
WMT-H	4220	L-LP-DF-AF	LP	L-DF-AF
WMT-H	4221	*	L-LP-DF-AF	
WMT-H	4222	*	L-DF	LP
WMT-H	4223	*	LP	L-DF
WMT-H	4225	*	LP	L-DF-AF
WMT-H	4228	L-LP-DF-AF	LP	L-DF-AF
WMT-H	4229	L-DF	L-DF	
WMT-H	4301	*	L-DF	L-DF-AF
WMT-H	5000	NF	AF	
WMT-H	7300	NF	AF	L-DF-AF
WMT-H	7800	NF	AF	LP
WMT-I	3104	NS	AL-WB-AF	
WMT-I	3202	NS	ES-AF	AF
WMT-I	3203	NS	AF	WB
WMT-I	4102	*	AF	
WMT-I	4203	*	WB-ES-AF	
WMT-I	4206	*	AF	
WMT-I	4207	*	AF	WB
WMT-I	4208	*	WB-ES-AF	
WMT-I	4212	*	WB	DF-LP-AF
WMT-I	4215	*	AF	
WMT-I	4219	AL-WB-AF	WB	AF
WMT-I	4220	DF-LP-AF	WB-ES-AF	
WMT-I	4221	*	ES-AF	
WMT-I	4222	*	AF	
WMT-I	4223	DF-LP-AF	WB-ES-AF	
WMT-I	4225	*	AF	
WMT-I	4228	*	AF	DF-LP-AF
WMT-I	4301	QA-MC	WB	
WMT-I	5000	NF	AF	WB
WMT-I	7300	NF	AL-WB-AF	
WMT-I	7800	NF	WB	AF
WMT-I	8100	NF	WB	
WMT-I	9100	NF	AL-WB-AF	
WMT-J	3104	NS	AL	AF
WMT-J	3202	NS	AF	
WMT-J	3203	NS	AL	AF
WMT-J	4201	ES-AF	AL	
WMT-J	4203	*	AL	AF
WMT-J	4208	AF	AL	WB
WMT-J	4212	*	AF	WB
WMT-J	4219	WB-ES-AF	AF	AL
WMT-J	4220	ES-AF	AL	WB
WMT-J	4221	*	AL	AF

Potential Vegetation Group	SILC cover-type	Direct Assignment of SILC to a SIMPPLLE state	Primary Re-assignment of SILC to a SIMPPLLE state	Secondary Re-assignment of SILC to a SIMPPLLE state
WMT-J	4223	*	AF	AL
WMT-J	4225	*	AL	AF
WMT-J	4228	*	AL	
WMT-J	5000	NF	AL	WB
WMT-J	7300	NF	AL	WB
WMT-J	7800	NF	AL	WB
WMT-J	8100	NF	WB	AL
WMT-J	9100	NF	AL	AF
WMT-NF	3101	NF	NF	
WMT-NF	3102	NF	NF	
WMT-NF	3104	NF	NF	
WMT-NF	3202	NF	NF	
WMT-NF	3203	NF	NF	
WMT-NF	4102	*	NF	
WMT-NF	4201	*	NF	
WMT-NF	4203	*	NF	
WMT-NF	4206	*	NF	
WMT-NF	4207	*	NF	
WMT-NF	4208	*	NF	
WMT-NF	4210	*	NF	
WMT-NF	4212	*	NF	
WMT-NF	4219	*	NF	
WMT-NF	4220	*	NF	
WMT-NF	4221	*	NF	
WMT-NF	4222	*	NF	
WMT-NF	4223	*	NF	
WMT-NF	4225	*	NF	
WMT-NF	4226	*	NF	
WMT-NF	4228	*	NF	
WMT-NF	4229	*	NF	
WMT-NF	4301	*	NF	
WMT-NF	5000	NF	NF	
WMT-NF	7300	NF	NF	
WMT-NF	7800	NF	NF	
WMT-NF	8100	NF	NF	
WMT-NF	9100	NF	NF	